Thirty-five Centavos a Copy
Three Pesos a Year

The Philippine Agriculturist and Forester

Foreign Subscription: Two Dollars a Year

Entered at the Post Office at Los Baños, Laguna, as second-class mail matter

Vol. V September, 1916 No. 5

EDITORIAL

In another column of this issue, we announce three accessions to the faculty, and would call attention here to the fact that all of the new men hold degrees from a single American institution—the University of Wisconsin. So far as Mr. Gonzalez and Mr. Roxas are concerned, this has happened less because of the strength of Wisconsin in their particular fields of study than because of its eminence in the general field of public service.

We hold that the University of the Philippines, in common with other state universities, exists for the service of the state; that every form of public service which it can effectively perform is its proper function; that its attempts and its achievement alike are to be judged and measured, as a whole and in detail, by their subservience and conformity to this ideal. We regard the University of Wisconsin as the institution which has come nearest to the realization of this ideal. To the University, as exponent and molder at once of the spirit of the State, we ascribe more than to any other agency the eminence of Wisconsin in a variety of fields, from the production of the finest cheese to the most perfect economic legislation. We regard the state university as ultimately responsible for the fact that Wisconsin banks charge a lower interest rate than those of any other state west of Ohio.

We would have the Philippines be like Wisconsin in the quality of their products, in the universal welfare and enlightenment of their people, in the absence of the poverty which spoils citizenship. We would have our own University be another University of Wisconsin in the development and leadership of Philippine statehood. We, too, train our students to a sense of social responsibility. And we rejoice that our faculty grows by the addition of men trained in the best of schools for their part in the realization of these ideals.

—E. B. C.

Fertilization of Rice

By Cornelio Balangue y Rulloda

Thesis presented for graduation from the College of Agriculture, No. 61

Rice is the staple article of food in the eastern tropical and sub-tropical countries; in the Philippines it has been grown since time immemorial. Filipino farmers say that three or four decades ago the production per unit of area of rice in the islands was greater than that of today. Under favorable conditions the Philippines can unquestionably show good rates of yield. Yet the rate of production is decreasing year after year in all rice sections of the Archipelago, although the present methods of cultivation are unchanged, if not improved.

The total production of rice per unit of area in the Philippines in comparison with that of other rice-growing countries is shown in the following table published in The Philippine Agriculturist and Forester, *The Cost of Production of Rice by Philippine Methods*, by C. G. Aurelio (Vol. IV, No. 2, May, 1915).

TABLE NO. I

Country	*Area under rice in acres*	*Production in tons*	*Yield per acre in lbs.*
Spain	96,000	246,000	5,700
Italy	360,000	534,000	3,300
Egypt	254,000	375,000	3,300
Japan	7,393,000	7,026,000	2,100
United States	827,000	517,000	1,400
India	70,580,000	28,167,000	890
Philippines	2,991,000	723,000	485

This table shows that the Philippines stand the lowest in the rate of production; it is only about one-tenth that of Spain, or one-half that of India, which is in the same latitude, and where this crop was probably cultivated many years before its introduction into this Archipelago. Due to the declining total production, in spite of a gradually expanding area, the total yield is insufficient to meet the annual consumption of the people—the number of which is continually increasing.

Customs statistics show that the 1915 import was practically double the average import from 1899 to 1914 inclusive; and that rice forms about 20% of the total Philippine imports. The importation of our chief necessity, a food which our country can produce, shows that we are a long way from economic independence.

It is the common belief of a good many natives that the land of the Philippines is becoming "old" and "poor" and that this causes a decrease in the rate of production. True, our rice lands are old, but not so old as those of India, Japan, and China and the rate of production should not decrease if the lands were properly handled. Fertilization has been proved successful in the United States, Japan, China, Ceylon, Hawaii, etc. In the case of Japan, in spite of its small area and its great population, the country exports a part of its rice, as well as other agricultural products, to the Philippines, simply because the people are effectively using all available sources of fertility.

In view of the above facts the importance of seeking means of checking the importation of rice into our country by increasing our own rice crop is evident. The Bureau of Agriculture has shown that the rate of production may be increased through seed selection. Proper tillage is universally accepted as an important factor in agricultural development; but in the Philippines the number of work animals is too small to perform the required amount of tillage for all the existing

rice areas, so tillage cannot be carried out as it should be. Adequate irrigation is another essential factor in this problem. Because of the cost, the best irrigation works can be established only by the government. In his message to the Third Philippine Legislature, fourth session, the Governor General says: "The agricultural operations of the Islands were adversely affected during the autumn of 1914 by the continued drought, and large importations of rice from foreign countries were again necessary during the current year. This is a serious drain upon the resources of the people and an effort should be made to establish irrigation systems upon a sound basis, so that these Islands shall become self-supporting in the matter of food supply." There are about 125,000 acres of land under irrigation at the present time; but there are, at least, 1,250,000 acres more that could easily be brought under irrigation. But irrigation, alone, cannot insure an increased rate of production per unit of area, because the plant foods in rain water and those dissolved in and carried down by the water to the fields are not sufficient to meet the food demand of rice. Crop rotation is a well recognized means of upbuilding soil fertility, but in sections where irrigation is not available, and the dry season is severe, this is a very slow process. Obviously these recognized means taken together or separately will not meet our necessity; there must be added another means if our rice production is to be brought to its highest possible rate.

The most direct means to accomplish this is to restore the fertility of the depleted fields with plant food in the form of fertilizers. A plant, to attain its proper development, must have an available and adequate amount of soluble nutritive materials.

Fertilizer tests with rice have not, so far as records show, been carried out in these Islands except in a single trial performed in Alabang, Rizal, by the Bureau of Agriculture, an experiment which gave entirely negative results. In the Alabang experiment, single substances and several combinations of commercial fertilizers were used, but none of the fertilized plots surpassed the unfertilized ones. The reason for this result we do not definitely know; only by repeated trials on the same ground could the cause be determined.

Maintaining the fertility of the soil is an undisputed insurance of a good yield, both in quantity and in quality. As our average rate of production is increasing, it is safe to assume that the soil fertility is decreasing. This decrease is caused by the plants' removing a considerable fraction of soil fertility with every crop; and not only is nothing done to restore it, but many practices of farmers prevent natural means of giving back plant food to the soil. Commonly, just after harvest, animals are turned loose in the fields and they devour all the remaining plants, the ultimate manure product accumulating in corrals, and there being allowed to go to waste. The by-products of the paddy are thrown away or burnt and never returned to the soil. It is not an uncommon practice to burn the fields a few weeks after harvesting. This causes a great loss of plant food in the form of nitrogen, which vanishes in the process of burning, leaving only the potash and phosphorus on the ground; and if a heavy rain follows, these plant-food elements are washed out of the burnt fields and carried down into the streams.

It is the purpose of this study to find methods of increasing the rate of rice production in these Islands by using simple systems of fertilization.

The present work may be divided into three heads, namely:

1. To test simple systems of fertilization of both upland and lowland rice, using only materials and methods practicable for the common farmer.

2. To determine the best forms of locally available fertilizers for both upland and lowland rice.

3. To determine exactly the cost of those methods of fertilization and the exact gain resulting therefrom.

In order to obtain a fair basis for conclusions, the writer performed experiments in three different localities in the province of Laguna: at Calamba, at Los Baños, and at Calauan. These localities differ somewhat in climatic conditions and in length of growing season, and the soils are somewhat different, chemically and physically.

MATERIALS USED

As the real purpose of this work was to test simple systems of fertilization, using only materials and methods readily available to the common farmers, but often wasted, wood, grass, and rice ashes, and horse manure were the natural fertilizers first employed. There were also used double superphosphate, 40% phosphoric acid at ₱11.50 per 100 kilos; sulphate of ammonia (only tested at Calauan), 20% nitrogen, at ₱19.50 per 100 kilos; and common lime, at ₱2.24 per 100 kilos; the freight was ₱7.00 on 6000 kilos of each fertilizer. Except the fields in the Calauan Estate and the two upland fields on the College farm, the fields upon which these experiments were performed are owned by common farmers.

The seed was supplied by the farmers so there were nearly as many varieties used as there were farmers concerned. The implements were of native types, such as the wooden plow and the ten-tooth iron harrow.

A few of the old farmers presented the objection, to the use of carabao dung, that it contains numerous seeds of different kinds which germinate when put into the soil and cause a weedy rice plantation. This is true when the carabao is allowed to feed on wild grasses; but if it is fed with the ordinary grasses and cultivated crops, such as corn, rice straw, cowpeas, and other legumes, its manure will be of great value.

PROCEDURE

The methods used in these experiments are so simplified that an ordinary farmer can understand and use them without any assistance.

The fields, with the exceptions of the Calauan lowland and the College upland, are so located that they are about 1 to 2 kilometers apart. The farmers cultivated the fertilized and the unfertilized plots; in both kinds of plots they broadcasted the seeds; performed the seed-bed processes; transplanted, irrigated, cultivated, and weeded the plants without discrimination. So these plots can safely be assumed to have received the same treatment. On this assumption any difference in the production per unit of area can be said to be due to the effect of the fertilizers. Probable and unavoidable leaching must always be taken into account.

The horse manure was collected from the stables of the neighboring people. The wood and grass ashes were used only in the Los Baños experiments; the rice hulls for Calamba and Calauan fields were obtained from the mills. A petroleum box was used as the unit of measure for the natural fertilizers, and kilos for the commercial. The fertilizers were measured (ashes and manure pressed down), weighed with the greatest care, and applied accord-

ing to the area of the plots. The fertilizers were applied by broadcasting, care being taken that no loss or mixture occurred. The amount of application per hectare will appear in the tabulations.

Upland at Los Baños.—Usually the upland fields are undivided by even very low levees. After the fields were plowed, square or rectangular areas of from 56 to 100 square meters, numbered to correspond to the number of the fertilizers used, were marked out leaving 4 to 6 meters space between them. The purpose of the spaces was to avoid the mixing of the fertilizers. After broadcasting the fertilizers, to prevent loss, they were at once thinly covered with the surface soil by raking. The plowing and harrowing which followed throughly mixed the fertilizers into the soil.

In a few fields a special implement, called *panudling* in Tagalog, having three wooden teeth, was used for cultivation when the plants were from 6 to 12 inches in height. The purpose of this cultivation was to thin out the number of plants in the field.

Lowland at Calamba.—Fields that are reasonably far apart were selected in this region.

The irrigation water was allowed to run through the entire experimental plots by gravity.

The order of sequence of plots is the same as the order of the fertilizers in the tabulation of these fields. It is safe to assume that the highest plot received no other kind of fertilizers except the one applied, the next highest probably mixed somewhat with the fertilizer from one above but was free from the admixture of the fertilizers below, etc. But this probable mixing should not give marked differences.

Lowland at Calauan—Eight experimental fields were made from about two-thirds of a hectare of land. Each field was divided into six plots, ranging from 70 to 150 square meters, separated by levees. They received different kinds of fertilizers. In order to avoid the mixing of the different fertilizers by water, two canals leading to the outside, one to supply each plot with fresh water and the other for the exit of the water from the fertilized plots, were constructed. The controls were well scattered between the experimental fields and well protected from the entrance of fertilizers from the fertilized plots.

Before broadcasting the fertilizers, the plots having an excessive amount of water were drained until the water remaining was about two inches in depth. Thus, the fertilizers were more or less dissolved in a small quantity of water and naturally absorbed by the soil in a comparatively short time, with a low per cent of probable loss of food elements. After applying the fertilizers the plots were kept closed until the water was entirely absorbed by the soil. The fertilizers that were applied before transplanting were at once mixed with the soil by the harrowing which followed. The control of water was uniform for all plots.

Harvesting.—The upland and the lowland rice were harvested by practically the same method. The average representative sections, 2 by 5 meters, were carefully selected and measured off with the greatest possible care to secure the average stand of the plants in both the experiments and the controls. All panicles that belong to them were gathered, except the empty and immature ones. Although only one check was obtained for some of the experiments, it is safe to say that the result is approximately the same as by using two or more checks. The harvests were at once put in canvas bags to avoid shat-

tering, carefully labeled, perfectly threshed, winnowed and dried, and finally weighed to obtain the results. It must be remarked that the native methods of harvesting, threshing and drying rice introduce a considerable error in calculating the exact rice production of the Islands, as the losses are great during the processes. New and more economical methods should be adopted.

Cost of Fertilizers.—For the commercial fertilizers this means the market value of the fertilizers in the Philippines, plus the freight on them and the cost of labor in applying them, and the interest on their values.

For natural fertilizers it means the cost of labor in gathering them from the stables and rice-mills and applying them to the field, and the interest. The calculation was on the following basis:

1. A laborer with a carabao and a cart receives ₱2.00 per day when working 9 hours a day. (Regular rate in this locality).

2. By conservative estimate a laborer can bring and apply over the fields 80 petroleum boxes, the unit of measure, in one day.

This is a low calculation for a day's work in places where the materials are accessible.

If the farmer does the work himself, he saves this amount of cash expenditure and expends only his labor in applying the naturel fertilizers to his farm.

The value of the increase due to the fertilizers is calculated on the basis of ₱2.50 per cavan (57.5 kilos), or about ₱0.0435 a kilo, which is the average cost per cavan of palay or paddy in this locality.

It must be borne in mind that the following figures relate only to results of the first year, and the beneficial effects of the fertilizers extend over more than one year. It is only in comparatively few instances that the farmer can expect to obtain by increase of crops the full value of a fertilizer during the first year, but he will receive benefits through a series of years without further fertilization.

WEATHER CONDITIONS

The rainfall this year is considered to have been favorable for the growth of rice in this region, except that the upland rice before flowering was slightly affected by a drought. Storms occurred when the upland rice was nearly mature and caused a slight reduction in the amount of grain. When the Calauan lowland rice plants were set out, again when they were about knee-high, storms occurred, causing a retarding of growth; and when this rice was flowering, strong winds prevailed, preventing normal pollination and causing a high percentage of empty panicles, as rice is normally a self-fertilizing crop.

The following, from the College Weather Records, shows the weekly rainfall in this locality during the time of the experiments:

WEEKLY RAINFALL

	Date				
	1–7	*8–14*	*15–21*	*22–28*	*29–31*
May 1915	0.177 cm.	0.41 cm.	6.422 cm.	4.8754 cm.	0.0 cm.
June "	0.420 "	1.187 "	4.749 "	14.467 "	0.0 "
July "	0.558 "	4.151 "	9.0932 "	6.0616 "	3.8319 "
August "	3.162 "	3.3116 "	4.554 "	2.055 "	0.1016 "
Sept. "	2.525 "	22.84 "	6.055 "	16.49 "	0.52 "
Oct. "	6.81 "	8.11 "	3.08 "	24.66 "	2.60 "
Nov. "	9.94 "	11.92 "	4.79 "	3.67 "	0.07 "
Dec. "	9.16 "	45.70 "	2.67 "	0.55 "	0.21 "
Jan. 1916	7.46 "	2.14 "	0.03 "	1.01 "	0.60 "

FIELD NO. 1

CALAMBA LOW LAND

GRAY SANDY LOAM SOIL

This land has been under cultivation for many years. It has been planted with rice twice each year. The stand of the previous crops (rice) was poor and consequently the harvests were correspondingly poor. The straw was left and allowed to rot in the field. No particular injury from insects occurred, but the growth was affected by a grass called locally *apulid.* *

The field was plowed once and harrowed three times before planting. The seed variety (*mangasa*) was selected by the common method of the Filipino farmers—that is, the harvesting of all panicles from an average stand of plants in the field. The water supply was sufficient. Fertilizers were applied May 20, 1915; planting (broadcasting) was done, at the rate of one and one-fourth cavans per hectare, on June 8, 1915. The stand of all plots was poor. Harvested September 20, 1915.

The profit, ₱5.11 per hectare, or 46.3% on the investment in fertilizer, was obtained on the plot where lime was used.

FIELD NO. 1

Kind of Fertilizer	Amount per Hectare	Value ₱	Yield Ha.	Increase due to Fert. Kilos	%	Value ₱	+Gain Loss − ₱
			Kilos				
Check	0	0	1825				
Lime (CaO)	427.35 kilos	11.02	2196	371	20.33	16.13	+5.11
Ash	337.4 p. b.	7.63	1020	−805	−44.10	−35.02	−42.65
Ash and	159.25 p. b.	4.08	1426	−399	−21.86	−17.36	−25.51
Manure	159.20 p. b.	4.07					
Manure	366.63 p. b.	9.38	1288	−537	−29.42	−23.36	−32.74

FIELD NO. 2

CALAMBA LOW LAND

SOUTHWEST OF THE PLAZA

GRAY SANDY LOAM

This land has been cropped with rice for many years. The rate of production was very low. No injury caused by insects was noted. The grass *apulid* grew very thickly among the plants. Each year the field has been planted twice with rice and the straw left on the field for animals to eat or to decay; it is sometimes burned. Irrigation water is always available. Cultivation consisted of plowing once and harrowing three times. The seed, *dinagat,* was selected, by the same method as in No. 1. Not weeded at all.

Fertilizers applied May 20, 1915; seeds planted (broadcast at the rate of one and one-fifth cavans per hectare) June 22, 1915. The stand was fair. Harvested September 21, 1915.

The largest profit, ₱18.90 per hectare, or 135.8% on the investment in fertilizer, resulted from an application of manure. The next largest profit, ₱12.24 per hectare, was obtained from the plot receiving lime.

FIELD NO. 2.

Kind of Fertilizer	Amount per Hectare	Value ₱	Yield per Ha. Kilos	Increase due to Fert. Kilos	%	Value ₱	Gain + or Loss − ₱
Check	0	0	2375				
Lime (CaO)	545.40 kilos	14.06	2980	605	25.47	26.30	+12.24
Manure	530.30 p. b.	13.92	3130	755	31.70	32.83	+18.90
Manure and	227.27 p. b.	5.96	2200	−175	−7.36	−7.60	−19.10
Ash	216.45 p. b.	5.54					
Ash	293.65 p. b.	7.52	2370	−5	−0.21	−0.225	−7.745

*NOTE.—P.B. Petroleum box. The term apulid is applied locally to both *Cyperus difformis L.* and *C. Haspan L.*

FIELD NO. 3

LOS BAÑOS UPLAND

1 KM. EAST OF THE COLLEGE FARM

SANDY AND CLAY LOAM SOIL

The field is a coconut plantation, about five years old, the trees about eight meters apart. The land has been cultivated for the past seven years. The last two crops were corn; the previous crops were rice. The rice harvest was ordinary and the corn was poor. The straw and stalks had been allowed to decay on the field. The locusts caused little damage.

The seed (*inintiw*) was selected by the same methods as in No. 1. The field was plowed three times and harrowed once before planting. No weeding was done. Fertilizers were applied June 7, 1915. The field was planted (broadcast) at the rate of one cavan per hectare, June 7, 1915. Harvested October 5, 1915.

The plots fertilized with manure gave the greatest profit, per hectare. This was ₱23.01 per hectare, or 287.6% on the investment in fertilizer. The next largest profit was from the plot receiving ashes.

FIELD NO. 3

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.*			*Gain + or Loss –* ₱
				Kilos	*%*	*Value* ₱	
Check	0—	0	2540				
Manure	312.50 p. b.	8.00	3253	713	28.07	31.01	+23.01
Ash (1)	260.40 p. b.	6.67	3038	498	11.73	21.61	+14.99
Ash and Manure	130.20 p. b. 156.25 p. b.	3.33 4.00	2441	-99	-3.89	-4.31	-11.645
CaO	625 kilos	15.73	2639.6	99.6	3.92	4.33	-11.40

FIELD NO. 4

LOS BAÑOS UPLAND

EAST OF THE COLLEGE FARM

CLAY LOAM SOIL

This is new land, under cultivation only two years. The first crop was corn (planted twice a year); the second, rice. The stalks and straw had been piled on the field and burnt.

For this experiment the field was plowed five times and harrowed twice. The variety of seed used was *pinursigue*, selected by the common method. The field was weeded twice and the weeds carried out and piled along the border of the plots. No attack of insects was reported. Fertilizers were applied June 7, 1915. Planting (broadcasting) at the rate of one and one-fifth cavans per hectare was done June 12, 1915. Some leaching occurred. The stand was good. Harvested September 30, 1915.

The largest profit, ₱27.22 per hectare, or 290.5% on the investment in fertilizer, was obtained from an application of manure. The second largest profit, ₱18.50, was from the plot receiving lime; this profit was closely followed by the plots receiving ash and the combination of ash and manure.

FIELD NO. 4

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.*			*Gain + or Loss –* ₱
				Kilos	*%*	*Value* ₱	
Check	0	0	1484.8				
Ash (2)	357.14 p. b.	9.37	2019.5	534.7	36.01	23.26	+13.89
Manure	357.14 p. b.	9.37	2326.0	841.2	56.65	36.59	+27.22
Ash and Manure	178.57 p. b. 178.57 p. b.	4.685 4.685	1980.3	495.5	33.37	21.55	+12.18
CaO	446.425 kg.	11.51	2174.6	689.8	46.45	30.01	+18.50

(1) Grass ashes.
(2) Wood ashes.

FIELD NO. 5

LOS BAÑOS UPLAND

SOUTH-WEST OF THE COLLEGE FARM

SANDY AND CLAY LOAM

This land has been cultivated for three years. The first and second crops planted were rice (*inintiw* variety); the locusts devoured both crops. The straw that remained was left on the ground to decay.

For this experiment the ground was plowed four times (the last being after broadcasting the seeds) and harrowed twice. The seed, *inintiw,* was selected by the same method as in No. 1. Weeding was done twice and the weeds piled along the borders. The experiment was not disturbed by locusts or any other insect pests.

Fertilizers were applied June 7, 1915. The field was planted (broadcast) at the rate of one and one-fifth cavans per hectare, June 24, 1915. The rice was harvested October 13, 1915.

The greatest increase, 10.72%, was given by the application of ash, and the next, 7.20%, was obtained from the use of lime.

FIELD NO. 5

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.* *Kilos*	*%*	*Value* ₱	*Gain + or Loss −* ₱
Check	0		3179.00				
Ash (1)	625.00 p. b.	16.00	3520.00	341.00	10.72	14.83	−1.17
Manure	625.00 p. b.	16.00	3104.80	−74.2	−2.33	−3.23	−19.23
Manure and Ash	308.50 p. b. / 308.50 p. b.	8.00 / 8.00	3142.80	−36.2	−1.14	−1.57	−17.57
CaO	468.75 kilos	12.09	3408.00	229.00	7.20	9.96	−2.13

FIELD NO. 6

LOS BAÑOS UPLAND

SOUTH OF THE COLLEGE FARM

CLAY AND LOAM SOIL

This land has been under cultivation for five years. Corn was planted the first year followed by rice (*inintiw* variety) for four years; one planting a year was practiced. Harvests were poor, due to locust attacks. The seeds (*inintiw*) for this experiment were selected by the ordinary method. Straw stalks, and weeds were eaten by animals or allowed to decay. The field was plowed five times, the last time being after broadcasting, and harrowed once before planting. Weeding was done twice and the weeds were piled between the plants. The plants were not attacked by any insect pests.

The fertilizers were applied June 7, 1915. Planting (broadcasting) at the rate of one and one-fifth cavans per hectare was done June 12, 1915.

The stand was fair and the crop was harvested October 4, 1915.

A profit, ₱34.98 per hectare, or 435.1% on the investment in fertilizer, was obtained from the plot receiving wood ashes.

FIELD NO. 6

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.* *Kilos*	*%*	*Value* ₱	*Gain + or Loss −* ₱
Check	0	0	2337				
Manure	510.20 p. b.	13.39	2473	36	1.54	1.57	−11.82
Ash (2)	306.12 p. b.	8.04	3326	989	42.32	43.02	+34.98
Ash and Manure	153.06 p. b. / 255.10 p. b.	3.92 / 6.53	1834	−503	−21.52	−21.88	−32.33
CaO	350.00 kilos	9.03	2451	114	4.87	4.86	+4.17

(1) Wood ashes.
(2) Wood ashes.

FIELD NO. 7

LOS BAÑOS UPLAND

ABOUT ½ KM. NORTH OF THE COLLEGE FARM—SANDY LOAM

This land has been cultivated for three years previous to this experiment. Rice was the last crop and it gave a good rate of yield.

The preparation of the land was practically the same as employed in the other fields. The seed (*inacupanga*, glutinuous rice) was selected by the ordinary method. The plantation was not weeded.

Fertilizers were applied June 9, 1915. The field was planted (broadcasted) at the rate of 22 gantas per hectare, on July 3, 1915. The rice was harvested November 8, 1915.

The largest profit, ₱20.64 per hectare, or 206.8% on the investment in fertilizers, was made on the plot fertilized with the combination of ash and manure; this was very closely followed in profit by the plot which received ash. Every fertilizer made a profit, whether used singly or in combination.

FIELD NO. 7

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.* *Kilos*	*%*	*Value* ₱	*Gain + or Loss −* ₱
Check (Average of 2)	0	0	712.99				
Ash (Wood)	390.62 p. b.	10.24	1421.56	708.57	99.38	30.82	+20.58
Ash (Wood) and Manure	195.31 p. b. / 195.31 p. b.	4.99 / 4.99	1416.88	703.89	98.72	30.62	+2064
Manure	390.62 p. b.	10.24	1075.66	362.67	50.86	15.78	+5.54
CaO	375.00 kilos	9.66	1099.16	386.17	54.16	15.80	+6.14

FIELD NO. 8

LOS BAÑOS UPLAND

ABOUT 1 KM. NORTH-EAST OF THE COLLEGE FARM

LOAM SOIL WITH SMALL PERCENTAGE OF SAND

This is a field about six years old. The first three years, corn and sugar cane were planted alternately. Rice (*inintiw*) was planted in the remaining three years, but almost all of each crop was eaten by locusts. The straw remaining was allowed to decay. No burning of rubbish was done.

The field was plowed three times and harrowed three times before planting. The suds (*quinapi* and *binicol*) were selected by the common method.

Fertilizers were applied June 10, 1915. The field was planted (broadcasted) at the rate of 23 gantas per hectare, July 8, 1915. The rice was harvested October 18, 1915. Leaching was supposed to be considerable.

The highest profit, ₱26.20 per hectare, or 163.75% on the investment in fertilizer, was obtained from the plot where wood ash was used. The next highest, ₱7.56, or 39.25%, was on the investment in lime; this was very closely followed in profit by the plot fertilized with manure. All the fertilizers made profits, whether applied singly or in combination.

FIELD NO. 8

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.* *Kilos*	*%*	*Value* ₱	*Gain + or Loss −* ₱
QUINAPI							
Check (Average of 2)	0	0	2020.30				
Manure	750.00 p. b.	19.68	2637.21	616.87	30.54	26.83	+7.15
Ash (Wood) [1]	625.00 p. b.	16.00	2990.55	970.21	48.02	42.20	+26.20
Manure and Ash	375.00 p. b. / 312. 5 p. b.	9.84 / 8.00	2436.66	416.32	20.606	18.11	+0.27
BINICOL							
Check	0	0	2208.34				
CaO	781.25 kilos	19.26	2825.00	616.66	23.39	26.82	+7.56

(1) Wood ashes of *Antipolo* (*Artocarpus communis* Forst.)

FIELD NO. 9
COLLEGE FIELD
IN THE TRIAL BEDS
SANDY AND CLAY LOAM SOIL

This is newly opened grass-land. The seed (*inintiw*) was selected by the common method. The beds were raked and forked twice before planting. Weeding was done twice and the weeds were thrown outside of the plantation. When the plants were about one foot in height, locusts ate the leaves until the height was reduced to about five inches. At the flowering time a strong wind dislodged the plants. From fruiting time until harvesting, paddy-birds and chickens caused great damage. Leaching was supposed to be considerable.

Fertilizers were applied June 19, 1915.

Planting (broadcasting) at the rate of one cavan of seed per hectare, was done July 3, 1915.

Harvesting was done October 28, 1915.

Profit was made on a plot where manure was applied. The highest increase, 568.93 kg. or 23.44% over the control, was obtained from the plot fertilized with the combination of P_2O_5, ash, and manure, or complete fertilizer. All the other kinds of fertilizers caused increase in production, whether used singly or in combination.

FIELD NO. 9

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.*			*Gain + Loss −* ₱
				Kilos	*%*	*Value* ₱	
Check (Average of 2)	0	0	2426.84				
Manure	625.00 p. b.	16.00	2931.86	505.02	20.81	21.97	+5.97
P_2O_5	166.66 kilos	19.84	2995.77	568.93	23.44	24.75	−5.75
Ash (1)	208.33 p. b.	5.33					
and							
Manure	208.33 p. b.	5.33					
CaO (Lime)	1200 kilos	30.96	2927.51	500.67	20.63	21.78	−9.18
P_2O_5	250 kilos	29.76	2665.32	228.84	9.41	9.94	−27.82
and							
Manure	312.5 p. b.	8.00					
Manure	312.5 p. b.	8.00	2542.71	115.87	4.77	5.04	−10.96
and							
Ash	312.5 p. b.	8.00					
P_2O_5	250 kilos	29.76	2685.32	258.48	10.65	11.24	−26.52
and							
Ash	312.5 p. b.	8.00					
Ash	625 p. b.	16.00	2799.24	372.40	15.34	16.19	+0.19

FIELD NO. 10
COLLEGE FIELD
IN THE TRIAL BEDS
SANDY AND CLAY LOAM SOIL

This field was in its second year of cultivation. Before cultivation it was occupied by cogon. The first crop grown was sugar cane. The sugar cane gave an ordinary crop. This experiment was performed and treated as in the experiment on Field No. 9.

A combination of manure and ash gave the greatest profit, ₱54.75 per hectare, or 287.7% on the investment in fertilizers. The next greatest profit

(1) Wood ashes.

was made on the plot receiving lime, which was ₱42.54, or 274.8% on the investment in the lime. Next in profit were the plots which received the combination of manure and ash, and ash alone. The best increase, in kilos per hectare, due to complete fertilizer, was 1,696 kilos; to lime, 1334.0 kilos; to manure and ash, 830.5 kilos; and to P_2O_5 and manure 814 kilos.

FIELD NO. 10

Kind of Fertilizer	Amount per Hectare	Value ₱	Yield per Ha. Kilos	Increase due to Fert. Kilos	%	Value ₱	Gain + Loss− ₱
Check (Average of 2)	0	0	1623.00				
Manure	416.66 p. b.	10.67	1739.5	116.5	7.18	5.06	−5.61
P_2O_5	100.00 kilos	11.91					
Ash (1)	138.89 p. b.	3.56	3319.0	1696.0	104.49	73.78	54.75
and							
Manure	138.89 p. b.	3.56					
Lime (CaO)	600.00 kilos	15.48	2957.0	1334.	82.19	58.02	42.54
P_2O_5	150.00 kilos	17.86					
and			2437.0	814.0	50.15	35.40	12.205
Manure	208.33 p. b.	5.335					
Manure	208.33 p. b.	5.335					
and			2453.5	830.5	51.17	36.12	25.45
Ash	208.33 p. b.	5.335					
P_2O_5	150.00 kilos	17.86					
and			1827.5	204.5	12.6	8.90	−14.295
Ash	208.33 p. b.	5.335					
Ash	416.66 p. b.	10.67	2293.5	670.5	41.37	29.16	18.49

CALAUAN LOW LAND
⅓ KM. EAST OF THE PLAZA
SANDY AND CLAY LOAM SOIL

At this place eight experimental fields were used in an area of about two-thirds of a hectare. This piece of land is medium in fertility, although it has been cultivated more than twenty years. Rice was the only crop grown previous to this experiment. For the three years previous to the experiment, the Bureau of Agriculture in their experiment made one planting each year. Before that, the Calauan Estate had made two plantings a year. Some of the straw was eaten by animals and the rest was allowed to decay. No burning was done. Irrigation by a gravity system was accessible. The seeds used were *binangbang*, *piniling daniel*, and *macan*. The *binangbang* was furnished by the Estate, and selected by the German method,—selecting the best panicles from the field before harvesting. This is the product of a five-year successive selection. The others were from the Bureau of Agriculture, and selected by the same method. Practically no cultivation was given after transplanting. No tall grasses grew in the plots. The rate of planting (transplanted) is about 22 gantas per hectare. The seeds were soaked in water for germination, August 18, 1915; sown in seed bed, August 21, 1915; transplanted, October 12, 1915.

CALAUAN FIELD NO. 1

Seed—*Piniling Daniel.*

The fertilizers were applied September 12, 1915.

(1) Wood ashes.

The crop was harvested January 13, 1916.

The largest profit, ₱31.80 per hectare, or 244.4% on the investment in fertilizers, was made on the plot where a combination of manure, 275.3 petroleum boxes, and ash, 239.9 petroleum boxes, was used. The plots that received manure and ash separately gave little profits.

The use of the combination of manure and ash gave a percentage increase of 143.05 over the control.

Kind of Fertilizer	Amount per Hectare	Value ₱	Yield per Ha. Kilos	Increase due to Fert. Kg.	%	Value ₱	Gain + Loss − ₱
Check (Average of 2)	0	0	720				
Manure	454.5 p. b.	11.63	1140	420	58.33	18.27	6.64
Ash	555.5 p. b.	14.22	1120	400	55.55	17.40	3.18
Manure and	275.3 p. b.	7.05	1750	1030	143.05	44.80	31.80
Ash	232.9 p. b.	5.95					
Lime (CaO)	500 kilos	12.595	790	70	9.72	3.05	−9.54

CALAUAN FIELD NO. 2

Seed—*Macan.*

The fertilizers were applied September 12, 1915.

The rice was harvested January 13, 1916.

The very small profit of ₱2.75 per hectare, or 19.3% on the investment in fertilizer, was obtained from the plot where manure was used.

Kind of Fertilizer	Amount per Hectare	Value ₱	Yield per Ha. Kilos	Increase due to Fert. Kilos	%	Value ₱	Gain + or Loss − ₱
Check (Average of 2)	0	0	1020				
Manure	555.5 p. b.	14.22	1410	390	38.23	16.97	−2.75
Ash	625. p. b.	16.00	1080	60	5.88	2.61	−13.39
Manure and	274.49 p. b.	7.03	1170	150	14.71	6.53	−8.78
Ash	323.51 p. b.	8.28					
CaO	400 kilos	10.32	590	−430	−42.15	−25.67	−35.99

CALAUAN FIELD NO. 3

Seed—*Binangbang.*

The fertilizers were applied September 16, 1916.

The rice was harvested February 12, 1916.

Ninety-four centavos profit per hectare, or 5.4% on the investment, resulted from the combination of manure and ash.

Kind of Fertilizer	Amount per Hectare	Value ₱	Yield per Ha. Kilos	Increase due to Fert. Kilos	%	Value ₱	Gain + or Loss − ₱
Check (Average of 3)	0	0	1546.6				
Manure and	333 p. b.	8.52	1970	423.4	27.31	18.42	+0.94
Ash	350 p. b.	8.96					
Manure	625 p. b.	16.00	1700	153.4	9.92	6.67	−9.33
Ash	714.3 p. b.	18.29	1190	−356.6	−23.05	−15.51	−33.80
CaO	600 kilos	15.48	1720	173.4	11.21	7.54	−7.94

CALAUAN FIELD NO. 4

Seed—*Binangbang.*

Fertilizers were applied September 14, 1915.

The rice was harvested February 12, 1916.

The profit obtained was ₱19.34 per hectare, or 151.1% on the investment in manure at the rate of 500 p. b. per hectare.

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.* *Kilos*	*%*	*Value* ₱	*Gain + or Loss −* ₱
Check (Average of 3)	0	0	940				
Manure	500 p. b.	12.80	1680	740	78.72	32.19	19.37
Ash	500 p. b.	12.80	840	−100	−10.63	−4.35	−17.15
Manure and Ash	259 p. b. / 259 p. b.	6.63 / 6.63	960	20	2.02	0.87	−12.39
CaO	450 kilos	11.61	260	−680	−72.21	−29.58	−41.19

CALAUAN FIELD NO. 5

Seed—*Binangbang.*

The fertilizers were applied September 12, 1915.

The rice was harvested February 12,1916.

The only profit was ₱9.90 per hectare, or 85% on the investment in ash applied at the rate of 454-½ p. b. per hectare.

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.* *Kilos*	*%*	*Value* ₱	*Gain + Loss −* ₱
Check (Average of 3)	0	0	745				
Manure	416.5 p. b.	10.66	730	−15	−2.01	−0.65	−11.31
Ash	454.5 p. b.	11.635	1240	495	66.44	21.53	9.90
Manure and Ash	205.87 p. b. / 205.87 p. b.	5.27 / 5.27	900	155	20.81	6.74	−3.80
CaO	700 kilos	18.06	480	−265	−35.57	−11.530	−29.59

CALAUAN FIELD NO. 6

Seed—*Binangbang.*

The fertilizers were applied September 23,1915.

The rice was harvested February 12, 1916.

The largest profit, ₱46.28 per hectare, or 470.3% on the investment in fertilizer, was obtained from the plot on which manure was used. The next profit obtained was ₱17.14, or 166.9% on the investment in the combination of manure and ash.

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.* *Kilos*	*%*	*Value* ₱	*Gain + Loss −* ₱
Check (Average of 3)	0	0	850				
Manure	384.5 p. b.	9.84	2140	1290	151.76	56.12	+46.28
Ash	416.5 p. b.	10.66	850	0	0	0	−10.66
Manure and Ash	198 p. b. / 203 p. b.	5.07 / 5.20	1480	630	74.13	27.41	+17.14
CaO	800 kilos	20.64	1290	440	51.76	19.14	−1.50

CALAUAN FIELD NO. 7

Seed—*Binangbang.*

Fertilizers were applied September 16, 1915.

The rice was harvested February 12, 1916.

The largest profits were obtained from the manure and lime plots. The former gave a profit of ₱42.17 per hectare, or 439.3% on the investment in fertilizer, and the latter a profit of ₱42.72, or 551.9% on the investment. The combination of 176.46 petroleum boxes of manure and 426.44 petroleum boxes of ash gave a profit of ₱18.06 per hectare, or 116.2% on the investment.

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.* Kilos	%	*Value* ₱	*Gain + Loss−* ₱
Check (Average of 3)	0	0	940				
Manure	375 p. b.	9.60	2130	1190	126.59	51.765	+42.17
Ash	833 p. b.	21.32	1550	610	64.89	26.535	+ 5.22
Manure and Ash	176.46 p. b. / 426.44 p. b.	4.517 / 10.916	1710	770	81.91	33.495	+18.06
CaO	300 kilos	7.74	2100	1160	123.4	50.46	+42.72

CALAUAN FIELD NO. 8

Seed—*Binangbang.*

The fertilizers were applied October 12, 1915.

The rice was harvested February 12, 1916.

The largest profit, ₱27.71 per hectare, or 324.8% on the investment in fertilizer, was obtained from the plot where manure at the rate of 333⅓ p. b. per hectare was used. The next highest profit, ₱13.36 per hectare, or 57.9% on the investment in fertilizer, was obtained from the plot where lime was used. The plot fertilized with ash at the rate of 384 ½ p. b. per hectare gave a profit of ₱6.39 or 64.9% on the investment.

Kind of Fertilizer	*Amount per Hectare*	*Value* ₱	*Yield per Ha. Kilos*	*Increase due to Fert.* Kilos	%	*Value* ₱	*Gain + Loss −* ₱
Check (Average of 3)	0	0	1497				
Manure	333.33 p. b.	8.53	2320	823	54.97	36.24	+27.71
Ash	384.5 p. b.	9.84	1870	373	24.91	16.23	+ 6.39
Manure and Ash	164.84 p. b. / 191.31 p. b.	4.22 / 4.92	1770	273	18.23	11.88	+ 2.74
CaO	900 kilos	23.22	2338	841	56.17	36.58	+13.36

Ammonium sulphate and double superphosphate when applied, even in reasonable amounts, increase the rate of yield; but on account of their high market prices they are decidedly unprofitable.

CONCLUSIONS

1. Certain simple systems of fertilization of both upland and lowland rice, using materials and methods readily available for the common farmers are profitable.

2. Horse manure proved to be the best form of locally available fertilizer for both upland and lowland. Ashes come next. A combination of manure and ash proved to be needed by the common rice soils.

3. The complicated results in the different places show that definite formulae of fertilizers can not be made

for different localities, there being no uniformity of conditions. A formula for one field can not necessarily be used with success on another. Only by experiment can we find the fertilizers required for a certain area.

4. Under certain conditions, liming the soil increases the rate of production, and this is especially true of the "old" fields.

RECOMMENDATIONS

1. Horse manure should be applied at the rate of 250 to 350 petroleum boxes per hectare in order to be likely to obtain the greatest profit in upland and lowland fields.

2. Ashes should be applied at the rate of 300 to 500 petroleum boxes per hectare.

3. A combination of horse manure and ashes at the ratio of 1:1, should be applied at the rate of 250 to 500 petroleum boxes per hectare.

4. A complete fertilizer composed of about 100 kilos of double superphosphate and 100 to 200 petroleum boxes manure and of ashes may be profitably applied.

5. Natural fertilizers are to be preferred to commercial fertilizers at the present stage of our knowledge of rice fertilization, and at the present stage of development of the Filipino farmer; ammonium sulphate and double superphosphate should be used only in the making of complete fertilizers.

6. To increase the rate of production, lime may be applied at the rate of from 300 to 900 kilograms on new and long-cropped fields.

7. To increase the yield, carefully selected seed should be planted in fertilized fields.

8. Local tests on the fertilization of upland and lowland rice should be made everywhere in order to determine the requirements of any given soil.

ACKNOWLEDGMENTS

The author wishes to express his acknowledgements to Prof. Charles F. Baker, who not only supervised the work but also most generously rendered financial aid; to Mr. J. J. Schultz, the Manager of the Calauan Estate, who also supplied, not only the labor needed on the field, free of charge, but helped to defray the writer's transportation expenses; to Mr. Inocencio Elayda, for his ever ready assistance in carrying out the experiments; and to the farmers of Los Baños and of Calamba for the free use of their lands and their help, without any compensation, in carrying out the field work.

REFERENCES

1. Report of the Bureau of Customs, Fiscal Calendar Years 1914-1915.

2. The Philippine Agriculturist and Forester, Vol. IV, No. 2, May 1915.

3. Rice in the Philippines by H. O. Jacobson.

Local Growth of Rubber and Guttapercha Plants

By Roman O. Sarmiento

Thesis presented for graduation from the College of Agriculture, No. 52

The possibility of rubber and gutta production in the Philippines is indicated by the presence of wild species, producing both gutta and rubber; by the fact that climatic conditions are in general similar to those of prominent producing countries, and, finally, by the actual production on rubber plantations.

Of guttas, an old report by Dr. Sherman, of the Bureau of Government Laboratories,[1] lists nine native species of Palaquium, beside *Payena Leerii*, one of the important sources of commercial gutta, reported native in Tawi-Tawi. Of rubber-producing indigenous plants, the greatest promise is given by the genus *Ficus*, with an enormous number of native species, although what wild rubber has been obtained in the Philippines is the product of the vines *Chonemorpha* and *Parameria*. The different wild figs produce latex of great variety, offering a promising field of investigation.

A number of rubber plantations have been started in the Philippines, and on other plantations, rubber has been planted incidentally in association with other crops regarded as staples. As a rubber plantation, the only successful one up to this time is that established and managed by Dr. Strong, near Isabela de Basilan. At this place, Mexican and Ceara rubber have been tried and discarded; Para rubber has been successful and is now paying the cost of the plantation, including a rather rapid extension of area. On the plantation of Mr. Orville Wood on the Gulf of Davao, Mexican and Para rubbers were planted, and Mexican rubber proved the more successful under the local economic conditions. The most considerable publication on Philippine rubber [2] has been by Mr. W. I. Hutchinson of the Bureau of Forestry. Beside this, there have been several publications by the Bureau of Agriculture, and by persons interested in the promotion of rubber plantations or the development of a rubber industry.

At the College of Agriculture, as complete a collection of rubber-producing plants as possible was assembled several years ago. Experience with these various plants has brought College authority to the conclusion that conditions of temperature and rainfall at low altitudes in all parts of the Islands are suitable for some rubber-producing plant or other; but that rubber-producing plants as a whole are so susceptible to damage by storms that the establishment of rubber plantations is not a safe business undertaking, except in the extreme southern part of the Archipelago. In the far south, in the "belt of tropical calms," where typhoons are practically unknown, Para rubber can be expected to succeed, where wet and dry seasons are not too distinct, and Mexican rubber to succeed where the dry season is severe. The more recently discovered species of *Manihot*, and some of the rubber-producing vines, have still to be given careful test; the vines, but not the *Manihots*, may be cultivated where typhoons occur, if they prove able to produce rubber at a satisfactory profit.

Growth of Rubber Elsewhere

Observations on the rate of growth have been published in various parts of the world, *Sapium* in British Guiana, *Castilloa* in Mexico, *Manihot* rubbers in Hawaii and elsewhere, and *Hevea* in

various places, notably, the Malay States and Ceylon.

At Heneratgoda, Ceylon, the record of the growth of one tree over a period of 14 years showed a reasonably uniformly distributed total increase in circumference of from 1 ft. 4 in. in 1880 to 6 ft. 8 in. in 1894, an average increase in circumference of a little over 4.5 inches per annum. Trees in the state of Selangor [9] grew to a height of 30 ft. with a girth of 19 inches in four years. "The Director of Agriculture for the Federated Malay States quotes the average growth in that country as 3 to 9 inches girth in two years, 10 to 30 inches girth in four to six years and 30 to 60 inches in seven to ten years."

Rubbers on the College Farm

Experiments with rubbers at the College of Agriculture show marked local variation, indicating that a soil suitable for one kind of rubber may not be favorable for the others. It is of importance to study thoroughly these conditions, and locations, including the soil and subsoil and their influence on the growth of the various rubbers.

Plantings of rubbers at the College of Agriculture have been made at various times during the past few years. The species of rubbers now existing on the College Farm are the *Manihots* (several species), *Hevea*, *Castilloa*, *Cryptostegia* and *Mascarenhasia*. They are planted under widely differing conditions.

For measurements, there were selected 4 trees, and 25 seedlings for *Castilloa*, 20 for *Manihot*, 26 for *Hevea*, 3 for *Mascarenhasia* and 5 for *Cryptostegia*.

The *Manihots* are planted under very widely differing conditions. The first nine are on the bank of the river, where there are also some *Heveas*, but they are in a separate group. The other *Manihots*, numbering seven, including three *M. Piauhyensis*, are in an open field. The soil on the bank has a considerable depth. A hole dug here to over 3 ft. deep, showed no sign of hard subsoil. It is a combination of alluvial soil, very fine clay loam, and some small pieces of adobe rock. The soil of the *Manihot* field is a compact dark loam inclined to be clayey. The subsoil is adobe rock with little clay. Its depth varies from about 35 to 80 cm.

The Hevea trees are located in various places on the farm. The first eighteen trees are on the bank of the river; another set of eight trees are on a hillside among forestry plantings. Those on the bank of the river were retransplanted by stumps taken from the open field, where they had not grown well. They are nearly half shaded in this place. The other group of *Heveas*, on the hill mentioned above, are fully shaded by high trees. The soils in these places differ widely in texture; that on the bank is an alluvial soil, while that on the hill is a sticky clay,—recently decomposed adobe and inclined to be dark. The subsoil is adobe rock.

The *Castilloas* are planted along a drive and are not at all shaded. The soil in this place is of a fine compact loam, inclined to be clayey. Its depth varies from 71 to 81 cm. The subsoil varies from clay sand on the lower part to adobe rock in the upper. Another group of *Castilloas* are still seedlings, planted in bamboo pots and kept in a lath-house.

The *Guttas* (*Palaquium* and *Payena*) and *Mascarenhasias* are on the bank of the river, half shaded by bamboos and other trees. The soil is a fine compact sandy loam which does not contain much clay. The subsoil is also sand but not finer than the top soil. The subsoil near the edge of the river is very stony.

The *Cryptostegia madagascariensis*, since they are climbing plants, are planted close to the bases of large trees.

GROWTH RECORDS

The accompanying summary table gives full data pertaining to the growth of the different species of rubber on the College farm. This table is compiled, from the weekly growth records of the present experiment.*

This experiment is based on sixty-five trees covering the different species of rubbers. Some of them were planted as seeds, some as stumps, and some arrived here as seedlings. The seedlings are a year old and those from stumps are more than a year old.

The measurements were made at different times, thus No. 1 began July 28, 1914; Nos. 2 and 3, June 30, 1914; Nos. 4 and 5, July 2, 1914; Nos. 6, 7 and 8, June 30, 1914; No. 9, October 20. 1914; No. 10, December 3, 1914; No. 11, September 15, 1914; and No. 12 November 5, 1914.

The present study ended January 19, 1915, for Nos. 1, 2, 3, 7, 8, 9 and 11; and January 21, 1915 for Nos. 3, 4, 5, 10, and 12.

The average weekly growths during the period of measurements are summarized as follows:

	Plant Location	Age	Weekly Growth
			cm.
1st	River-bank *Manihot dichotoma*	2 yr.	6.2
2nd	River-bank *Hevea brasiliensis*	4 yr.	2.5
3rd	Hillside *Manihot dichotoma*	4 yr.	1.9
4th	Hillside *Manihot piauhyensis*	4 yr.	1.8
5th	Roadside *Castilloa elastica*	5 yr.	1.5
6th	Hillside *Cryptostegia madagascariensis*	4 yr.	17.8
7th	Riverside *Payena Leerii*	1 yr.	0.55
8th	Riverside *Mascarenhasia*	2 yr.	0.5
9th	Riverside *Palaquium oblongifolium*	1 yr.	0.4
10th	Riverside *Palaquium Treubii*	1 yr.	0.2
11th	Potted *Castilloa elastica*	¾ yr.	0.18
12th	Hillside *Hevea brasiliensis*	4 yr.	0.00

* Mr. Sarmiento's tables of field measurements would fill this issue of the Agriculturist and Forester. They are filed in the records of the Department of Agronomy.

Though hillside *Cryptostegia madagascariensis* has the most rapid vertical growth, it should not be considered an especially good grower on the whole, for it is a climbing plant. In this case it is placed sixth in the list.

Of the trees, river-bank *Manihot dichotoma* made the greatest growth, the next being river-bank *Hevea brasiliensis*. The location of these two, on the river bank, greatly favors their growth. The others are also fair growers, excepting only the hillside *Hevea brasiliensis* in dense shade. The shaded *Heveas* show a great difference in the terminal and lateral growths.

The relation of growth to rainfall varies. On the whole, there is a greater growth in the rainy season, than in the dry season. Although *Cryptostegia madagascariensis* is not an important rubber, its growth in the dry season is very remarkable; it does not seem to suffer at all from the dryness of the soil and heat of the sun. The river-bank *Manihot dichotoma* and *Hevea brasiliensis* also made a remarkable growth both in the rainy and the dry seasons. The poorest growth in both the rainy and the dry seasons was made by the densely shaded *Hevea*, for during this study, no terminal or lateral shoots seemed to develop. In this locality, the rainfall averages (for several years) 50.56 inches in the wet season and 9.88 inches in the dry season. It can be deduced briefly, that if *Hevea* can thrive in this place, having only a few inches of rainfall for parts of the year, then, so far as rainfall is concerned, it should be able to do well in most parts of the Philippines, at low altitudes, at least, since the rainfall in many regions runs even to 120 inches.

The greatest terminal and lateral

growth during the wet season are as follows:

Name of culture	Increase
	cm.
Riverbank *Manihot dichotoma*	70.9
Hillside *Manihot dichotoma* and hillside *Manihot piauhyensis*	36.6
Riverbank *Hevea brasiliensis*	26.6
Roadside *Castilloa elastica*	9.0
Riverside *Payena Leerii* and riverside *Palaquium oblongifolium*	8.0
Riverside *Palaquium Treubii*	4.8
Riverside *Mascarenhasia*	0.1

Growth records of potted *Castilloa elastica*, hillside *Cryptostegia madagascarensis*, and hillside *Hevea brasiliensis* were not taken in the rainy season.

Due to the fact that some young trees do not have branches, it is a difficult matter to state briefly the results in comparison with the larger trees. The young plants, however, from the beginning of the study, grew steadily but not rapidly. This is shown especially in the riverbank *M. dichotoma*. The roadside *Castilloa elastica* shows no greater growth than the above. The riverside *Palaquium Treubii* has the least growth and spread, even though it has well-developed branches.

The diameter growths also vary considerably under different conditions. The experiment shows that in all the trees there is a definite relation of growth of the terminal shoots to the diameter. There is only one exception, and that is in the shaded hillside *Hevea brasiliensis*. The trees may not increase in spread but the diameter continues to increase if the terminal shoot is active. Riverbank *Manihot dichotoma* shows an increase in diameter of 1.75 cms. from July 28, 1914, to January 19, 1915, a fairly good growth for a tree only two years old. The most rapid growth in diameter is that of the hillside *Manihot dichotoma*, this being 2.1 cm. from July 2, 1914; to Jan. 21, 1915, at the age of four years. The poorest growth in diameter is that of riverside *Palaquium Treubii*, which gave only 0.04 cm. from 30, 1914, to January 15, 1915.

The order of growth in diameter may be summarized as follows:

Rank	Name of culture	Increase
		cm.
1st	Hillside *Manihot dichotoma*	2.1
2nd	Riverbank *Manihot dichotoma*	1.75
3rd	Hillside *Manihot piauhyensis*	1.4
4th	Riverbank *Hevea brasiliensis*	0.79
5th	Roadside *Castilloa elastica*	0.67
6th	Riverside *Mascarenhasia*	0.4
7th	Riverside *Payena Leerii*	0.24
8th	Hillside *Cryptostegia madagascariensis*	0.2
9th	Hillside *Hevea brasiliensis*	0.12
10th	Riverside *Palaquium oblongifolium*	0.09
11th	Potted *Castilloa elastica*	0.08
12th	Riverside *Palaquium Treubii*	0.04

Of all the growths observed in the different species of rubber, *Hevea brasiliensis* showed the most striking periodicity. After growing actively for about four weeks, it stops, and remains stationary for about the same length of time, with the exception only of those trees in full shade. Too much shade is objectionable.

From the above discussion, the rates of growth appear to compare well with those of rubber-producing regions. Taking the rate of growth of *Hevea*, which runs to about twelve feet per year in the Tarkwa Botanic Station, Gold Coast, as compared with our trees, which run to about 11 feet, the Philippine trees stand second. The summary table shows 6.2 cm. of average terminal increase of the well-grown *Ceara*.

SUMMARY

1. There is a greater growth of rubber in this locality in the wet season than in the dry season, so that total growth would probably be greater in localities with a more evenly distributed rainfall.

2. The diameter growth seems to be correlated with the growth of the

terminal shoots, except in the case of *Hevea* in dense shade.

3. The growth of *Hevea* here is very different from that of the other rubbers in that it shows a striking periodicity.

4. The surrounding conditions have much to do with growth; thus, very slow growth or none is shown by *Hevea* and *Manihot* in dense shade; luxuriant growth in partial shade; and medium growth in the open.

5. The soil most preferable is a combination of alluvial soil, and fine clay loam. The soil on the high bank of the river is the most favorable on the College grounds. The *Manihot* and the *Hevea* thrive most luxuriantly in this place.

6. Medium growth occurs on fine, compact loams, inclined to be clayey, which have a depth of from 35 to 81 cm. as for example in the case of *Manihot* and *Castilloa*.

7. There is a greater variation in terminal growth than in spread, under our conditions.

8. *Castilloa* showed less growth in the vertical shoot and in diameter of trunk than did *Ceara*, even though they were under nearly the same conditions.

9. Most of the rubbers on the College Farm seemed not to suffer greatly from drought.

10. The growth of *Ceara* and of *Castilloa* in the unprotected fields is hindered by severe dry winds. Also they do not stand up well in strong winds.

11. So far as the present observations of these rubbers show, no insect or fungus enemy seemed to greatly damage them. The termites are the only enemies, and these attack some of the trunks of the largest *Cearas*.

12. Under the varying conditions of rainfall in the Philippines, there is a wide margin of *possibility* in rubber growing in these Islands.

13. A thorough practical knowledge concerning soil, surroundings and climatic conditions is necessary in determining where to establish rubber plantations.

Bibliographical References

1. Reports of the Philippine Commission, Part III, 1906, pp. 569-598.

2. Reports on Rubber Growing Industry of the Philippine Islands, pp. 2-15.

3. *India Rubber and Gutta Percha*, Part II, p. 19.

4. *Cyclopedia of American Agriculture*, edited by L. H. Bailey, Vol. II, p. 556.

5. *The Tropical Agriculturist*, 1903-1904, p. 726.

6. Report of the Philippine Commission, Part I, 1906, p. 369.

7. *Kew Bulletin*—Additional Series, Vol. VII and VIII, pp. 89 and 94.

8. *West Indian Bulletin*, Vol. XIII, No. 3, pp. 241, 242, and 260.

9. *The Cultivation and Preparation of Para Rubber*, by W. H. Johnson, pp. 22-25.

In closing the writer wishes to express his thanks to Prof. Charles F. Baker for his valuable suggestions and criticisms throughout the course of the work.

Tests and Selections of Mungo Beans

By Lucio Antonio San Miguel

Thesis presented for graduation from the College of Agriculture, No. 64.

The *mungo* is the most popular legume among the Filipino farmers and has been grown in these Islands for many years. Its cultivation, after the rice has been harvested, has been one of the chief activities in the northern provinces, especially in Pangasinan, where a large quantity of seed is produced every year. A large part of the *mungo* product is eaten in the Philippines but some is exported to China. [5]

In other provinces besides Pangasinan, the *mungo* is also cultivated, but the raising of seeds, intended for home consumption only, is confined to very few small patches. It should be grown on a larger scale, for it is a very productive and easily cultivated crop, and will grow in almost any kind of soil and endure a wide range of moisture conditions. [5]

In India, Java, China, Japan and Korea, the *mungo* takes a prominent place in general farming. It has been in cultivation from time immemorial and serves a wide field of usefulness for human food, even if it is considered to be only of secondary importance. It is also used as forage, green manure, and to some extent, for medicine.

According to Dulhi and Fuller, the *mungo* is grown in India as an intercrop with millet or cotton, but more often by itself. [1] When grown alone it is sown broadcast at the rate of 10 to 13 kilos per hectare. Sowing takes place at the commencement of the rains and maturity comes at different times depending, of course, upon the variety and the soil. [1]

Its value as a nitrogen-fixing crop makes it very effective for green manuring and in parts of Pangasinan, Nueva Ecija, and some other provinces the *mungo* is planted in alternation with rice for its beneficial action upon the soil fertility.

The *mungo* is also used as a cover crop. It covers the ground well, chokes out the weeds, and, in adition, gives a good yield of seeds. Experiments performed at the Lamao Experiment Station resulted, among other things, in the recommendation of *mungos* as one of the best leguminous cover crops. In the dry season, as a cover crop, it is the only substitute for cowpeas. [7]

The bean is greatly relished by live stock, including chickens, and this use finds justification because of its protein, carbohydrates, and fat content—thus furnishing in itself a nearly balanced ration. This food value should be appreciated by poultry growers in the Islands, but owing to its present high price, it has been shown in the work of a graduating student this year that its use does not pay.

The *mungo* is a native of Southern Asia, but is now widely distributed throughout all warm countries. [1] It has recently been introduced into America, but very little information concerning it there has been published. [2] The time of its introduction into the Philippines is very uncertain, for no record relating to it is availble. It is supposed, however, that early traders, Chinese, Hindus, Japanese or Spaniards, brought it into this country.

There are, at least, two important species cultivated in the Philippines, the *urd* (*Phaseolus Mungo*) and the *mung* (*Phaseolus aureus*), originally termed *radiatus*. [6] These two species are known to the Filipino as *mungo*. The *adsuki* (*Phaseolus angularis*) is similar to them and is included in the present work. The *adsuki* is one of the

most productive legumes in Japan.[2] Its seeds are imported into the Philippines in large quantities. These are three of the five oriental species of beans which Prof. C. V. Piper recently stated to be good crops as seed producers, so that their possibilities are well worth further investigation in the Philippines.

Unfortunately, there has been considerable confusion in the nomenclature of these three species, due chiefly to Roxburgh having transposed the original Linnean names.[1] The *adsuki* has even been confused with the very different *urd* and the rice bean. The *urd* and the *mung*, two closely related species, have been greatly confused in literature. The following key is quoted from the U. S. Department of Agriculture, Bulletin No. 119, and is a basis for the distinction and classification of these species:

"I. Leaflets parted into three or five lobes.......................... *Moth*
II. Leaflets entire or occasionally 2 or 3 lobed
  1. Plants and pods very hairy, seeds mostly dull.
    A. Pods with short hairs, seeds globose or subglobose, green, rarely brown, blackish or yellow, the testa marked with fine crenulate lines, hilum not concave.. *Mung*
  2. Plants almost smooth or little hairy, seeds smooth and shiny
    A. Pods constricted between the seeds, hilum not concave....... *Adsuki*
    B. Pods not constricted between the seeds, hilum not concave.... *Rice*[2]"

As to their economic value and their possible adaptability to conditions prevailing in these Islands, there appears to be no good reason why they should not become one of our valuable crops. Seemingly, no real work on increasing the yield per unit of area has so far been attempted. In the present study, an attempt has been made to increase the yield per unit of area, first by systematic selection, and second by testing and acclimatization of different varieties.

The important points which govern selection are productivity, evenness of maturity, heavy production of vegetable matter, resistance to disease, and suitability to seasonal conditions.

BOTANICAL CONSIDERATIONS

Phaseolus Mungo Linn.—Urd, Black or Green

There are at least two distinct varieties of *urd* in India, one with large, black seeds and the other with smaller greenish seeds.[1] Both of these are cultivated in the Philippines, the former being most generally known in the province of Nueva Ecija and other neighboring provinces.

The *urd* is everywhere cultivated in Asia, but is rarely seen in the United States.[3] It resembles the soy beans in habit, erect or nearly so, 30-60 cm. high, stout, with the furrowed stem densely clothed with long brown hairs; leaves large and long-stalked;leaflets very broadly ovate or nearly rhomboid, orbicular, usually entire, thin, short, acute; stipules large, ovate; flowers fully self-fertile, rather small, yellowish in a capitate cluster of 5-6 on the end of the stout hairy peduncle, pods 3 inches or less long, nearly cylindrical, somewhat curved, bearing 10-15 seeds each.[3]

It is very similar to the *mung* and the botany of the two has become much confused, but it is distinguished by its much stouter, shorter, very hairy pods and larger oblong seeds.[2] In Bombay it occupied in 1906, 90,700 hectares.

In botanical characters the *urd* resembles the *mung* but in the general behavior, the plants are lower and spreading, the branches procumbent. The variety under the name of *tikari* occurs probably only in India.[2]

There is still room for slight doubt regarding the botanical name applied in the *urd*. There is no specimen labeled *Phaseolus Mungo* in the Linnean

herbarium. Prain pointed out, however, that Linneaus' description of *Phaseolus Mungo* accords better with the *tikari* than with any other related species, and his judgment, based on a wide knowledge of the Indian species, can hardly be controverted. [2]

The *urd* is utilized as a green-manure crop under the name of "woolly pyrol," and forms the chief food of the Hindu laborers. In the United States, it seems far less desirable for food than other species, and less useful than cowpeas or soy beans as a forage crop.

Phaseolus angularis (Willd.) W. F. Wight.—ADSUKI

The *adsuki* bean is much cultivated for human food in Japan and Chosen and to a less extent in China, Manchuria, and India. [2] It is imported into the Philippines in large quantities in spite of the fact that it can be grown here, where conditions are similar in many respects to those of the southern part of Asia. Next to the soy bean, it seems to be the most important legume in Japan. On the relatively poor soils of Arlington Farm, in the Eastern United States, it produced very heavy crops of seed, up to 5223 liters per hectare, a yield which is not exceeded by the soy bean. [4] The first literature on *adsuki* bean in Europe is a brief description by Kaempfer. His drawing of the plant was later published by Banks. [2] This led Willdenow to name the plant *Dolichos angularis*. Still, most botanists have confused this species with others. That it is confused with the *mung* or *urd* is largely accounted for by the very little known about it. Even in Japan the *adsuki* bean has been called *Phaseolus Mungo* or *Phaseolus radiatus*, from both of which it differs greatly. The plant is not known in its wild state. However, it is probably a native of Southern Asia.

The *adsuki* bean is a summer annual, requiring the same conditions of climate as the common bean, and is best planted at the same season. Both the *mung* and the *urd* are like the *adsuki* as to susceptibility to disease.

Bulletin No. 119 of the United States Department of Agriculture gives the following description:

"The plants are bushy in habit, growing from 30 to 75 cm. high, according to variety and soil. The early varieties are strictly bushy in habit, and mostly erect, while the later ones are slightly viny at the tips of the stems and branches and some of them are decumbent. As with other legumes, the later varieties are larger than the early ones. The whole herbage is somewhat hairy, and the leaves persist until the pods are fully mature. The flowers are bright yellow, 6 to 12 in a cluster.

"The pods are straw-colored in most varieties, brown in a few, and blackish in a considerable number. In size the pod varies with the seeds, the longest pods being 5 inches long, the shortest, 2.5 inches. Each pod bears normally 8 to 10 seeds. The pods do not shatter readily, but as they are thin, the beans may germinate in the pods in long-continued wet weather.

"The seeds are subcylindric or but slightly longer than broad. The following colors occur in the order of their frequency: Maroon, straw to nearly white, gray (really black-speckled on a greenish-yellow ground color), maroon and straw, black-brown, blue-black, and straw." [2]

At least sixty distinct varieties have been tested at Arlington Farm, and these are distinguished most markedly by their different times of maturity and by the color of pods and seeds. At Arlington Farm the earliest varieties are fully mature in three months, while the latest require five months. The fact that varieties are numerous is accounted for

by hybridization, and, where they are grown near together, new sorts will constantly appear.

Its introduction into the United States from Japan dates back to as early as 1854, the red-seeded bean being the first sample tested. In 1891, two varieties, the black-o and the white-podded, were tested as human food at the Kansas Experiment Station by Prof. C. C. Georgeson, [8] the test resulting favorably.

Phaseolus aureus ROXB.—MUNG OR GREEN GRAM

The *mung* is a native of India and is found wild and cultivated throughout the plains, ascending to 3,000 meters in the outer ranges of the Northern Himalaya Mountains. [1] From India to Africa and Greece as well as to other parts of the Orient, the plant has been introduced, principally by Hindus. In Europe, it seems not to be cultivated. Like the *adsuki*, it is not definitely known in its wild state. but Prain is inclined to think that it is a cultivated derivative of *Phaseolus radiatus* L. (*Phaseolus sublobatus* Roxb.), which grows wild in India. According to Mollison, this legume is sixth in importance in the Bombay Presidency, about 80,972 hectares being grown each year, mostly mixed with cotton or millet. [1]

The seeds are used for food and the straw is fed to cattle. It has received different names in different places where it is grown. Among these are *chiroco* in Eastern Africa, *bundo* in Japan, and *Jerusalem pea* in Jamaica, where it is used largely as a green-manure crop. [2]

The confusion concerning the proper botanical name has been recently cleared up by Sir David Prain, Director of the Royal Botanical Gardens at Kew. [2] The *mung* was well known by previous botanists and well figured by Dillenius. [2] Linneaus, through having confused it with the *urd* and even with the soy bean, never gave a binomial name to the *mung*. Several names have been for a time adopted by botanists, which, on account of confusion with other similar legumes, have made it impossible to come to a permanent agreement. *Phaseolus Max* L., which has been referred by some botanists to the *urd*, is really the soy bean, shown clearly by Linneaus' original specimen, which still exists. While he intended to apply this name to the *mung*, the plant he actually described was the soy bean. [2] The name *Phaseolus Mungo*, which properly applies to the *tikari*, a form of the *urd*, has even been given to *mung*. In 1832, Roxburgh changed the application of Linneaus' names in several respects, applying the name *P. Mungo* to green-seeded *mung*, *P. Max*, to the black-seeded *mung*, and *P. radiatus* to the *urd*. These changes of Roxburgh cannot be accepted. He also named the golden-seeded *mung* *P. aureus*, which was first published, and which, because it properly belongs to the *mung*, must be accepted as its proper botanical designation. [2]

The *mung* is an annual plant, erect or sub-erect, rather hairy, branchy, growing to a height of 35 to 120 cm., depending on variety. Some are naturally climbing; the best varieties rise to bush forms. The leaves are trifoliate, with rather large, ovate, entire or rarely trilobed leaflets. The flowers are pale yellow, crowded in clusters of 10 to 25. They are fully self-fertile when bagged, setting pods perfectly.

The varieties differ in habit, size, period of maturity, color of pods, and size and color of seeds. At Arlington Farm, the earliest varieties mature their first crop of pods in about 140 days. Pods are black or brownish and vary in length from 6 to 10 cm., each containing 10 to 14 seeds. The seeds are globose or oblong, green in most varieties; but in others, marble-black and green-yellow, brown, and purple-brown. The weight

of 100 seeds ranges from 1.5 to 5.2 grams. The seedcoat is marked by many fine, wavy ridges, which are sometimes very faint, but apparently never entirely lacking. Sometimes nearly smooth seeds and strongly striate seeds are found in the same pod. The seeds of *P. sublobatus* are similarly striate, but those of the *urd* are smooth. [2]

Regarding the introduction of this bean into the United States, it is evident from the same reference that the earliest record was made previous to 1835, at which time the bean had received many common names. Comparative tests have been made at Arlington Farm, where *mung*, as a field crop, did not excel cowpeas and soy beans.

USES OF MUNGO

Different species of varieties here discussed serve as food for human beings in various ways. Some of the important uses are here given:

ADSUKI BEANS.—The *adsuki* is sold and eaten in many places in the Islands, especially in large towns near Manila, the latter being the center for their use. In all mungo parlors or stores, it may be noticed that cream mungo or *sorbete mungo* forms one of the chief articles of sale. This refreshment is prepared by boiling the seeds in water for several hours and sweetening them with sugar, then adding crushed ice and milk. It is a very profitable business in all parts of the Islands, for this is a very acceptable confection to many classes of people. In Japan, whence the *mungo* is obtained in large quantities, cakes and various confections are extensively used. In every Japanese city are shops where the *adsuki*-bean meal is prepared by grinding the beans, and then removing the seed coat by means of sieves. A wet process is also commonly employed which varies in different parts of Japan. But in a general way it consists of four essential stages:

"1.Boiling the beans until soft, usually after a preliminary soaking.

"2. Crushing the cooked beans.

"3. Removing the skins by forcing the mass through sieves or by putting the bean paste in cold water, when the skins are easily separated.

"4. Drying the bean paste.

"The fresh, undried bean paste is called *an* and the dried product *sarashi-an*. A modification of the above process is to remove the seed coats from the soaked and parboiled beans before they are crushed. In boiling, the red color of the seed coat dissolves and on this account the water is sometimes changed once or twice. The final product is somewhat reddish, however. The bean meal, in whatever way prepared, is eaten in soups, gruels, and in various kinds of cakes and confections. *Adsuki* beans are also eaten popped like corn, as a coffee substitute, and candied by boiling in sugar; the last product is called *amanatto*. The flour is also used for shampoos and to make facial cream."

MUNG AND URD.—These two closely related species of *mungo* beans are extensively used for food for men and animals in the Philippine Islands. The vines are fed to cattle and horses, the green pods are eaten as vegetables, and the beans are boiled and eaten whole or after being split, in a form like the *dal* of India. In Java, the beans are eaten in the form of young seedlings, and the bean is regarded as a cure for beri-beri. It is said that the Javanese consume it, not so much because it is liked, as for its value as a preventive of this disease. [5] In India, of the pulse crops, *mung* brings the highest price. [1]

CHEMICAL ANALYSES

Comparative analyses of the seeds of these beans and of kidney beans are described in Bulletin No. 119, U. S. Department of Agriculture, as follows:

TABLE I

Plant	*Analysis made by*	*% of Water*	*% of Ash*	*% of Crude Protein*	*% of Crude Fat*	*% of Crude Fiber*	*% of Nitrogen-Free Ext.*
Adsuki bean	Bureau of Chemistry	10.06	3.40	19.22	0.40	4.55	63.37
Mung bean	Church	11.40	3.80	23.80	2.00	4.20	54.80
Urd bean	Church	10.10	4.40	22.70	2.20	4.80	55.80
Kidney bean	Brooks, 1892	13.00	3.56	19.75	1.22	—	62.27

The result of chemical analyses of the hay of *urd*, *mung* and *adsuki* and of cowpea, made by the Bureau of Chemistry, are shown in the following table:

TABLE IA

Plant	*% of Water*	*% of Ether Ext.*	*% of Protein*	*% of Crude Fiber*	*% of Ash*	*% of Nitrogen Free Ext.*
Mung	7.18	1.47	10.69	2.57	8.40	51.69
Urd	7.66	1.31	12.72	23.33	10.92	15.06
Adsuki	7.68	2.03	17.66	23.04	9.87	39.72
Cowpea	10.50	2.60	14.20	21.20	8.90	42.60

PRESENT WORK

VARIETY TESTS

One of the objects of the present work was the testing of native and foreign varieties at different intervals so that a comparative study of their reactions to different seasons would enable us to determine the time of the year best suited to the growing of each strain.

To secure suitable varieties, as foundation stocks for breeding and selection, often requires extensive testing of introduced and standard varieties in this locality, under the conditions for which an effort is to be made to breed improved varieties.

Another aim in view was the acclimatization of foreign strains. Certain varieties may be successful in many regions but when brought to this locality, where conditions are different, they may behave in a different way, especially in the beginning. After tests and acclimatization for several generations, it may be found that the varieties are being gradually adapted to the local conditions.

All College varieties were assembled, examined, and reference made to the previous records kept by the Department of Agronomy. Of the varieties found, only a few have been used in this work on account of there not being a sufficient amount of seeds of the others for reasonable planting. The following varieties were used:

TABLE II

College No.	*Date received*	*Origin*	*Color of Seed*	*Latin name*
406 F3	June 6, 1912	Japan	Green	Phaseolus Mungo
523 F3	June 3, 1912	Los Baños	Yellow	Phaseolus aureus
3908	Jan. 24, 1915	Java	Green	Phaseolus aureus
4303	May 6, 1915	Japan	Red	Phaseolus angularis
4394	June 6, 1915	U. S. D. A.	Green	Phaseolus Mungo
4780	September, 1915	Nueva Ecija	Black	Phaseolus Mungo

Plantings were made at intervals, beginning May 20, 1915. Some of the varieties were allowed to remain growing for considerable period of time, even when they were found to bear no pods on the chance that later on, under favorable conditions these plants might develop flowers and pods. The seeds obtained were used in the succeeding plantings.

In order to make a general comparison of the behaviors of different varieties at different seasons, a record of weekly growth measurement was made, taken from at least five normal plants in each variety. The measuring commenced when the young plants were about 10 centimeters above the ground. Besides growth measurements, complete data as to yield of each variety were kept from every planting test. Table III contains the weekly growth in millimeters and table IV, the yield in kilos obtained per hectare.

TABLE III

AVERAGE WEEKLY GROWTH MEASUREMENT

Planting I. May 20, 1915.

Week ending	406F3	3908	4303	523F3	4394	4780
19-VI-15	38	55	38	23	—	—
26-VI-15	63	76	21	45	—	—
3-VII-15	151	72	31	92	—	—
10-VII-15	161	98	40	129	—	—
17-VII-15	124	129	84	187	—	—
24-VII-15	334	211	43	250	—	—
General Average	145	108	143	121	—	—

Planting II. August 10, 1915.

20-VIII-15	25	70	—	35	—	—
27-VIII-15	56	80	21	60	19	—
4-IX-15	97	105	70	30	28	—
11-IX-15	175	126	50	305	60	—
18-IX-15	343	295	177	219	107	—
25-IX-15	259	258	133	425	77	—
General Average	159	155	90	179	58	—

Planting III. October 15, 1915.

15-XI-15	65	55	21	63	33	92
22-XI-15	150	123	66	119	123	129
29-XI-15	154	199	115	50	195	200
6-XII-15	238	237	127	415	192	308
General Average	227	179	97	265	102	132

Planting IV. January 4, 1916.

17-I-16	28	50	20	47	27	13
24-I-16	38	48	43	68	33	75
31-I-16	50	175	29	150	48	154
7-II-16	85	213	56	139	33	198
14-II-16	220	218	43	200	58	216
21-II-16	178	388	50	411	31	320
General Average	100	182	40	169	38	163

TABLE IV

YIELD IN KILOS PER HECTARE

Variety	Planting I	Planting II	Planting III	Planting IV
$406F_3$	480 Kg.	435 Kg.	See below	250 Kg.
$523F_3$	310 Kg.	420 Kg.	See below	665 Kg.
3908	360 Kg.	496 Kg.	See below	512 Kg.
4303	195 Kg.	318 Kg.	See below	——
4394	——	236 Kg.	See below	194 Kg.
4780	——	——	See below	410 Kg.

NOTE.—The harvest for planting III is not recorded because it was very small, owing to previous damage by typhoons.

CONDITIONS GOVERNING EACH PLANTING AND RESULTS

Planting I. Planted May 20, 1915. Owing to a previous rain, the soil at this time was sufficiently moist and friable and the seedlings grew rapidly for a few weeks. In the early part of June, the growth was rather slow, due to the absence of rain and the prevalence of hot weather. Many plants in most of the varieties suffered, and almost all the plants in the variety 4303 were killed. Several weeks later, a good rain came and the plants recovered. Replanting was made in case of failures, and cultivation commenced as early as weeds appeared. When most varieties were about to flower, there came a continuous hard rain and wind which hindered the plants in giving a satisfactory yield. The variety $406F_3$, after having flowered quite early, was not much damaged, but the yield was lower than normal. The varieties 4303, 3908, and $523F_3$ did not flower well, but on being allowed to remain on the land for 3½ months, met a condition which favored the development of flowers. Later, there was not much rainfall and wind to interfere with successful pollination. Bright sunshine hastened maturity of pods. Those plants which failed to produce pods gave abundant vines and long leafy branches. Of the pods developed, some were spoiled by long-continuous wet weather, the seeds germinating inside the pods.

Planting II. Planted August 10, 1915, using the same materials, including the newly received variety, 4394, from the United States Department of Agriculture. More perfect and uniform germination was obtained. Rain came very often, especially in September, but the plants on high ground were not badly affected by the excess of water. The ground was moist, friable and free from weeds. The plants produced better results than in the previous planting and it required a shorter period for the plants to develop and produce pods. Among the varieties planted, only the new variety, 4394, gave a poor yield. With the *adsuki* bean, $4303F_1$, still better results were obtained than in the previous generation. The varieties $406F_4$, $523F_4$, and $3908F_2$ produced at this time more seeds, although the production of green matter, or hay, was lowered. The success of this planting seems to have been accounted for by the absence of rain or wind during its period of flowering, so that pollination was unhampered. There was good sunshine towards the fruiting stage and the quality of seeds was not spoiled. Harvesting commenced as soon as the first pods were matured and was repeated several times, until all pods were harvested.

Planting III. Planted mostly in the trial plots, October 15, 1915, and germinated after 3 to 4 days. Rains at this time caused many seedlings to die,

leaving only a few plants partially uninjured. Soon after the rainy days, some replanting was done when the ground was sufficiently mellow to permit cultural treatment. The rains were moderate enough to keep the soil always moist. The plants were more vigorous and promised better results; but typhoons came in the early part of December, when the plants were setting flowers and developing numerous pods, and laid the plants flat on the ground. Some that gave promise of surviving were given careful treatment. The yield obtained was low and was not recorded.

Planting IV. On January 4, 1916, another attempt was made to plant the same varieties in plots and patches, giving all the necessary attention to their culture. During the first half of January there were frequent showers which gave the plants a fine start. Frequent cultivation was maintained to keep the moisture in the ground. The month of February had a very low precipitation, so that irrigation was employed in this month. Many plants in varieties $406F_2$ and $4303F_2$ died from some disease, and others grew very slowly, resulting in many stunted plants. Only a few varieties grew successfully under these conditions. The foreign variety, $3908F_2$ seemed to be the most resistant variety, and well adapted to the conditions. The native varieties, $523F_5$ and $4780F_1$, were very productive. Almost all varieties showed a tendency to fail in the driest soil.

SUMMARY OF RESULTS

1. All varieties covered in this work can be grown in the wet season, but owing to the frequent occurrence of hard winds and rains, which hinder the perfect development of flowers, it is not always advisable to grow *mungos*. Besides this fact, the growing of *mungos* in the wet season seemed likely to result in the production of much herbage and few pods by most of the varieties. However, there are periods in the same season when only moderate rains come every few days, and hard wind is practically absent. Under these conditions the growing of an early variety like $406F_5$ should be profitable.

2. The previous work of the Department of Agronomy, with variety $406F_5$ and for several years, seems to show that the latter part of the wet season or the early part of the dry season, i. e., December, is the best time for *mungos* in this locality. At this time of the year the rains and wind come moderately and the soil is well supplied with moisture.

3. Varieties $3908F_2$, $523F_5$ and $4780F_1$ were the only varieties which grew successfully during the dry season on the College farm.

4. Concerning the foreign varieties, interesting observations were made. The seeds obtained from variety $4303F_1$ in the first generation were smaller in size than the original seed-stock. It is probable that through several testings and acclimatizations, this variety would produce normal seed. Variety $4394F_1$ was dwarf in habit, early, and variable. Both of these varieties grew best in the wet season. Variety $3908F_2$ is the only foreign sample that was readily acclimatized, and proved worthy of a permanent place on the College farm.

5. The age of flowering, fruiting and maturity of pods varies with different plantings. The present work, together with the previous work conducted by the Department of Agronomy, as tabulated below, will show the variations which were due to seasons of the year.

TABLE V

Variety	*Date planted*	*Date germinated*	*Date flowered*	*Date of maturity*
406	Nov. 19, 1912	Nov. 22, 1912	Dec. 15, 1912	March 26, 1913
406F_1	Nov. 7, 1913	Nov. 10, 1913	Jan. 7, 1914	Jan. 12, 1914
406F_2	Jan. 19, 1915	Jan. 22, 1915	Feb. 12, 1915	March 21, 1915
406F_3	May 20, 1915	May 23, 1915	June 21, 1915	July 20, 1915
406F_4	Aug. 10, 1915	Aug. 13, 1915	Sept. 13, 1915	Oct. 6, 1915
406F_5	Oct. 15, 1915	Oct. 18, 1915	Nov. 26, 1915	——
406F_5	Jan. 4, 1916	Jan. 7, 1916	Feb. 6, 1916	Feb. 20, 1916
523F_1	June 21, 1913	June 24, 1913	Aug. 1, 1913	Sept. 2, 1913
523F_2	Aug. 6, 1914	Aug. 10, 1914	Sept. 23, 1914	——
523F_3	May 20, 1915	May 23, 1915	July 19, 1915	Aug. 6, 1915
523F_4	Aug. 13, 1915	Aug. 16, 1915	Sept. 20, 1915	Oct. 9, 1915
523F_5	Oct. 16, 1915	Oct. 19, 1915	Dec. 2, 1915	——
523F_5	Jan. 4, 1916	Jan. 7, 1916	Feb. 10, 1916	March 15, 1916
4303	May 20, 1915	May 23, 1915	July 20, 1915	Aug. 10, 1915
4303 F_2	Oct. 15, 1915	Oct. 18, 1915	Nov. 30, ...	——
4394	Aug. 14, 1915	Aug. 17, 1915	Sept. 20, 1915	Oct. 10, 1915
4394 F_1	Oct. 15, 1915	Oct. 18, 1915	Nov. 23, 1915	——
3908	May 20, 1915	May 23, 1915	July 25, 1915	Aug. 16, 1915
3908 F_1	Aug. 16, 1915	Aug. 18, 1915	Sept. 20, 1915	Oct. 6, 1915
3908 F_1	Oct. 19, 1915	Oct. 22, 1915	Dec. 2, 1915	——
3908 F_2	Jan. 8, 1916	Jan. 11, 1916	Feb. 15, 1916	March 14, 1916

USE AND EFFECT OF NATURAL FERTILIZERS

Different varieties were treated with natural fertilizers consisting of well-rotted manures, ash, and their mixture. Before planting and after plowing, the ground was top-dressed with fine or well-rotted stable manure, ash, or mixture, as the case might be. The ground was then well prepared, and planting began August 25, 1915. The following table gives the yield in kilos obtained per plot:

Fertilizer	*Variety 406F_4*		*Variety 523F_4*		*Variety 3908F_1*		*Variety 4303F_1*	
	Seed	Hay	Seed	Hay	Seed	Hay	Seed	Hay
Manure	1.36	33.70	1.04	37.00	1.98	33.89	0.26	13.56
Ash	2.66	26.18	2.85	26.98	2.00	28.66	0.66	11.00
Mixture	1.88	30.80	2.08	30.65	1.95	34.58	0.20	13.05
Check	2.36	25.20	2.50	28.00	2.09	30.00	0.40	10.35

If seed is to be produced, natural fertilizer in the form of well-rotted manure alone should not be applied except to soil decidedly poor; as the plants become too vigorous, and produce only few pods. Well-rotted manure is rich in nitrogen and when applied to *mungos* or similar legumes seems to be a disadvantage. The effect toward increasing the production of vegetable matter, which can be used for green manure, is, however, great.

Ash greatly increased the yield of seed. The plants in ashed soil are low in habit, not viny with stiff and strong stems, but the pods produced are numerous. Moreover, the harvest was earlier and the quality of seeds fine. This single experiment, however, cannot be at all conclusive, and should be repeated. The present results are merely presented just as they occured.

The application of well-rotted manure and ash in combination gave abundant yield of hay but at the expense of seeds. However, a heavier yield of seeds than that by using well-rotted manure alone

was produced. The flowers and pods appeared and ripened unevenly, and the harvest was delayed.

The check represented the typical clay-loam soil of the College Farm. The yield was slightly smaller than the plot treated with ash but the general habit and behavior of the plant was similar to the plant on ashed soil.

From the above results the following statements may be made:

1. Well-rotted stable manure increased the hay and decreased the yield of seed.

2. Ash increased the production of seed, strengthened the body of the plant and caused early maturity.

3. Ash and well-rotted manure, when applied in combination, did not increase the yield of seed, and the plant produced long leafy branches, big stalks, but few pods.

4. The ordinary soil of the College Farm need not be fertilized for this crop or apparently for other legumes under the present conditions; but, if fertilized, ash may be used to advantage.

METHODS OF PLANTING

Planting of *mungos* begins after the rice has been harvested. The local farmers employ two methods of planting; one is by broadcasting and the other is hilling. Sowing broadcast is used in many places where the soil is deficient in nitrogen, for the purpose of green manuring and seed, while the drilling or the hill method is mainly intended for seed production, and is the one followed in the course of this study.

In the first method, the field is plowed and harrowed after the rice harvest, and the farmer, with a basket of seeds, goes over the field sowing the seeds broadcast at the rate of 50 to 65 liters of seeds per hectare. The seeds are covered with the harrow after the sowing. This practice of broadcasting requires little or no cultivation and is only suitable in level fields, where the ground is well cultivated and clean of weeds previous to seeding, so that the plants, with favorable weather, can grow rapidly and smother any seeds which may start. Sometimes the farmer makes furrows 50 to 70 cm. apart, and sows the seeds broadcast into the furrows. In this case provision is made for the cultivation of the rows.

For the greatest production of seeds, *mungos* are commonly planted in rows about 70 cm. apart, dropping the seeds in the rows, 2 or 3 cm. apart, and then covering with a thin layer of moist soil to secure even germination. The usual method of planting resembles that of corn, but the distance in planting varies with the season.

In the rainy season, when the growth of plants is great, more spacing is required for the production of seeds. In some localities *mungos* are sometimes interplanted with corn.

SOILS

While light clay loam soil is most desirable, sandy or even gravelly loam may be used; but the latter soils should contain more or less humus, and gravelly soils should not be too coarse. Mungo beans can be grown on heavy clay soil, but the surface or underground drainage, or both, should be such as to permit good aeration and special attention must also be given to cultural methods to produce a fine, mellow soil. *Mungos*, when grown in heavy soil, produce but a small crop at the first planting, but in the second or third planting they grow better, which probably results from the soils being opened and enriched by the deep root system of the plant. For this reason, it is also true that these soils, as renovated or built up by these legumes, produce good stands of any crop which follows.

Muck soils, or those with a superabundance of humus, are not suitable, as they tend to produce vines or long, leafy branches, at the expense of the seed. Like other legumes, *mungos* do not thrive well on low, wet, poorly drained soils, nor are they particularly adapted for dry farming in this locality unless very careful culture is given. *Mungos* seem to produce good crops or soils somewhat deficient in nitrogen, when well supplied with potash and phosphorus. The plants are long-rooted, and thus may extract food from soils almost barren to other crops. They are able to grow from the start on newly opened land, without inoculation with the bacteria which live upon their roots and aid in securing nitrogen from the atmosphere.

SELECTION

In the selection of mother plants, the writer made it a point to disqualify the plants which were vigorous and productive due simply to especially favorable local conditions of soil and space. There is no reason for selecting a prolific plant under such conditions, for the productiveness of the plants is a purely temporary character.

The present selection was made in the field before harvesting. The whole field was inspected, first row by row, and then plant by plant in each row, labeling all those individuals which were conspicuous among their neighbors growing under the same conditions, and, which at the same time, possessed the desirable characteristics. Plants which were late in maturing, diseased, or weak, even if they possessed a considerable number of pods, were not marked.

In the course of the selection, it was observed that the productivity of a plant is generally associated with other characters, such as numerous branches, vigor, and abundance of vegetable matter or straw. There are many distinguishing marks correlated with productivity, the discovery of which requires careful examination of individual yield and of the plant as a whole.

Harvesting of the pods commenced as soon as maturity came, and was repeated at several intervals, allowing the late pods to mature before the complete harvest was made. The pods were placed in labeled envelopes, each representing one individuals yield. Each selected plant was then pulled up, described and weighed. All harvested pods were taken to the laboratory for final selection.

The seeds were shelled out of the pods, and were put back in their respective envelopes. After the seeds were sufficiently dried in the sun, the weight of each plant was taken. All individuals proving decidedly inferior were thrown into the common stock, and the remainder were saved and further examined. The data obtained are placed in the following table.

GENERATION I

TABLE VI

Plant No.		*Height in cm.*	*No. of Branches*	*Weight of Plant in grams*	*No. of Pods*	*No. of Seeds per Pod*	*Weight of Seeds in grams*	*Weight of 100 Seeds in grams*
$406F_4$-I-	1	55	8	98	41	10	21.	4.
$406F_4$	2	45	6	98	50	11	23.5	3.9
$406F_4$	3	60	6	96	63	11	26.8	3.9
$406F_4$	4	48	5	90	78	8	24.55	3.9
$406F_4$	5	50	5	80	43	10	20.1	4.0
$406F_4$	6	52	6	78	49	10	22.5	4.1
$406F_4$	7	56	5	88	42	10	20.7	3.9
$406F_4$	8	63	6	115	78	12	32.4	4.0
$406F_4$	9	53	8	69	58	13	24.1	4.0
$406F_4$	10	52	8	93	66	12	22.85	4.0
$406F_4$	11	47	7	112	65	11	28.00	4.1
$406F_4$	12	55	5	96	44	10	20.8	3.8
$406F_4$	13	66	7	98	50	8	27.00	4.1
$406F_4$	14	67	6	73	42	9	20.40	3.9
$406F_4$	15	60	5	71	42	10	20.00	3.8
$406F_4$	16	54	6	95	60	12	24.4	4.0
$406F_4$	17	50	5	107	56	13	19.3	4.0
$406F_4$	18	53	5	98	46	11	22.1	4.1

(*a*) Seeds are green in color and oblong in form.
(*b*) Number of days from flower to harvest, 25.
(*c*) Days from planting to harvest, 59.
(*d*) Weather, rainy.

GENERATION I

Plant No.		Height in cm.	No. of Branches	Weight of Plant in grams	No. of Pods	No. of Seeds per Pod	Weight of Seeds in grams	Weight of 100 Seeds in grams
3908F_1-I	1	100	8	200	42	12	10.5	3.9
3908F_1	2	99	8	195	51	8	14.0	3.8
3908F_1	3	95	6	146	40	11	12.0	3.8
3908F_1	4	85	9	113	58	12	18.5	3.9
3908F_1	5	110	8	195	57	12	13.4	3.7
3908F_1	6	70	6	189	54	12	14.0	3.6
3908F_1	7	114	5	105	64	12	20.3	3.7
3908F_1	8	112	5	150	55	11	14.7	3.9
3908F_1	9	75	6	202	58	8	12.6	4.1
3908F_1	10	88	6	154	33	9	13.0	3.9
3908F_1	11	75	7	246	62	4	15.0	3.8
3908F_1	12	66	8	121	60	12	14.3	4.0
3908F_1	13	68	6	195	40	9	13.5	3.9
3908F_1	14	73	5	106	65	12	16.5	3.6
3908F_1	15	81	6	116	58	11	16.0	3.9

(*a*) Seeds are green and oblong.
(*b*) Number of days from flower to harvest, 28
(*c*) Days from planting to harvest, 80.
(*d*) Weather, rainy.

GENERATION I

TABLE VI

Plant No.		Height in cm.	No. of Branches	Weight of Plant in Grams	No. of Pods	No. of Seeds per Pod	Weight of Seeds in Grams	Weight of 100 Seeds in Grams
523F_4-I-	1	80	78	100	60	12	22	4.0
523F_4	2	78	7	200	63	11	28.6	4.2
523F_4	3	84	8	105	50	13	20.8	4.1
523F_4	4	82	8	141	60	10	24.4	4.0
523F_4	5	83	8	99	42	11	20.3	4.2
523F_4	6	62	7	80	45	11	22.2	4.0
523F_4	7	55	6	98	50	11	23.0	4.0
523F_4	8	50	5	63	48	13	24.0	4.0
523F_4	9	80	8	180	35	11	18.5	4.1
523F_4	10	71	6	88	44	12	24.6	4.0
523F_4	11	66	5	105	56	9	23.5	4.1
523F_4	12	73	7	206	45	8	28.7	4.0
523F_4	13	80	5	130	30	9	25.8	4.0
523F_4	14	57	6	129	51	9	26.0	4.0
523F_4	15	66	6	137	35	8	24.8	4.0
523F_4	16	65	6	190	55	10	25.0	4.0
523F_4	17	78	7	180	63	12	28.6	4.2
523F_4	18	55	6	150	40	8	24.4	4.0
523F_4	19	48	7	206	44	11	23.0	4.0
523F_4	20	82	8	210	40	10	23.4	3.9
523F_4	21	50	6	215	46	10	27.0	4.0
523F_4	22	80	7	219	44	11	24.0	4.0
523F_4	23	80	7	180	35	11	18.5	4.1
523F_4	24	77	5	196	48	10	25.0	4.1
523F_4	25	73	5	120	46	8	25.0	4.0
523F	26	76	5	180	30	11	16.4	4.0

(*a*) Seeds are green and oblong.
(*b*) Number of days from flower to harvest, 25
(*c*) Number of days from planting to harvest, 68.
(*d*) Weather, rainy.

TEST-ROW CULTURES

The value of field selection lies in the comparison of the progenies of each chosen plant. Although a plant is a high-yielder, vigorous, or early-maturing, in the end it may turn out worthy of elimination. The hereditary quality of the selected plant, which is transmittable to its progeny, can only be ascertained by field trials.

A part of the selected seeds was planted in straight rows, 70 cm. apart, each row representing one initial selected plant; the seeds were planted in hills, 50 cm. apart. Several seeds were planted in each hill and then covered with fine moist soil.

Cultivation began when the plants reached a height of 10 to 15 cm., and was repeated as often as the ground showed sign of baking, or weeds occurred between the plants.

The plants in each hill were thinned to one or two, only the most vigorous plants being allowed to grow.

The yield of the test rows should not be compared with the yield previously obtained from the common stock, as the latter was planted in a different season. To have a reasonable comparison, a check was planted at the same time and was given the same cultural treatment and care.

During the test row culture, several interesting variations were observed. Among them was the tendency of many test rows to be quite superior to the others. Such rows had a good stand and had only a few, if any, low-yielding plants in them. Other test rows had

NOTE:—The selection work was successful throughout the second generation in varieties 406 F_4–1, 523 F_4–1 and 3908 F_1–1, so that the following series of tables refer only to these varieties. Selection was also made with other varieties, but as they failed in the second generation, no data are here given.

poor, weak or diseased plants. The harvest from each row was divided by the number of plants, to get the average performance of each plant. The data obtained are placed in the following table:

GENERATION II

TABLE VII

Row Numbers	*No. of Plants per Row*	*Yield per Row in Grams*	*Average Yield per Plant*	*Calculated Yield per Hectare*	*Yield Check per Hectare*	*Average Gain over the Check*
			Grams	Kg.	Kg.	Kg.
$406F_5$-II- 1	30	158.0	5.26	300.55	445.69	–145.14
” 2	30	210.5	7.02	450.06	”	4.37
” 3	30	375.9	12.53	715.94	”	270.25
” 4	30	355.6	11.85	675.55	”	229.86
” 5	30	118.7	3.96	226.28	”	–219.41
” 6	30	254.4	8.48	484.54	”	38.85
” 7	30	205.3	6.84	390.86	”	–54.83
” 8	30	482.0	12.06	689.11	”	243.42
” 9	30	317.0	10.56	633.39	”	187.70
” 10	30	226.6	7.55	431.41	”	–14.28
” 11	30	119.3	3.98	227.48	”	–218.21
” 12	30	293.0	8.76	557.67	”	111.98
” 13	30	415.5	13.85	791.36	”	345.67
” 14	30	235.6	7.85	448.58	”	2.89
” 15	30	200.6	6.68	381.70	”	–63.99
” 16	30	458.4	15.28	873.10	”	427.41
” 17	30	312.2	10.41	594.83	”	149.14
” 18	30	136.8	4.56	260.57	”	–185.18
$523F_5$-II- 1	22	163.5	7.5	428.55	542.8	–114.25
” 2	21	97.8	4.75	271.45	”	–271.35
” 3	24	286.3	11.84	676.54	”	133.74
” 4	22	156.6	7.12	408.00	”	-134.80
” 5	25	210.9	8.43	481.65	”	–61.15
” 6	25	260.0	11.82	691.12	”	148.32
” 7	20	195.5	9.78	571.85	”	29.05
” 8	23	316.8	13.78	787.38	”	24.58
” 9	23	123.4	5.37	306.85	”	–235.95
” 10	25	240.0	8.60	491.40	”	–51.40
” 11	25	263.0	10.53	601.76	”	59.96
” 12	21	277.9	13.23	755.95	”	213.15
” 13	24	216.4	9.02	515.40	”	–27.40
” 14	23	199.7	8.69	496.54	”	–46.26
” 15	22	236.6	10.76	614.87	”	72.07
” 16	25	418.0	16.90	965.68	”	422.88
” 17	24	315.6	13.15	751.40	”	208.60
” 18	23	156.2	10.90	682.85	”	80.05
” 19	23	368.6	16.00	914.26	”	371.46
” 20	23	183.5	7.98	455.83	”	–86.97
” 21	24	248.9	10.37	598.58	”	55.78
” 22	25	330.0	13.20	742.60	”	199.80
” 23	20	115.0	5.75	328.58	”	–214.22
” 24	24	316.0	13.18	753.12	”	210.30
” 25	23	315.8	13.80	788.53	”	245.73
” 26	20	210.0	10.00			

GENERATION II

Row Number	*No. of Plants per Row*	*Yield per Row in Grams*	*Average yield per Plant*	*Calculated Yield per Hectare*	*Yield of Check per Hectare*	*Average Gain over the Check*
			Grams	Kg.	Kg.	Kg.
$3908F_2$-II- 1	20	213.9	10.69	611.83	548.54	63.69
” 2	18	154.6	8.55	498.54	”	–113.29
” 3	17	195.8	11.52	658.25	”	109.71
” 4	18	216.1	12.01	685.68	”	137.14
” 5	19	145.3	7.64	437.75	”	–110.79
” 6	19	200.0	10.52	601.11	”	52.57

GENERATION II

TABLE II—Continued

Row Numbers	*No. of Plants per Row*	*Yield per Kow in Grams*	*Average Yield per Plant*	*Calculated Yield per Hectare*	*Yield Check per Hectare*	*Average Gain over the Check*
			Grams	Kg.	Kg.	Kg.
$3908F_2$-II- 7	20	346.4	17.34	968.24	548.54	419.70
" 8	17	196.0	11.52	658.25	"	109.71
" 9	17	166.8	9.80	559.97	"	11.43
" 10	18	211.6	11.75	671.39	"	122.85
" 11	20	116.0	5.80	331.41	"	–217.13
" 12	20	217.0	11.35	638.54	"	90.00
" 13	19	196.0	10.60	605.68	"	51.14
" 14	20	297.8	14.89	850.81	"	302.27
" 15	18	192.5	10.70	611.90	"	63.36

The yield of the test-row representing the progeny of the chosen plant is given in column 3 and was calculated on the hectare basis. The check is given in column 6, and the gain or loss of the pedigreed strain over the check is given in the last column. There was a loss in only a few instances.

The check, as given in column 6, for variety $406F_5$ per hectare is 445.69 kilos, as against the best yield of the selection, which is 873.10 kilos per hectare (Table VII, $406F_5$-II-16). The check obtained from variety $523F_5$ is 542.8 kilos, as against the best yield of the same variety under improvement, which amounts to 965.68 kilos (Table VII, $523F_5$-II-16). The variety $3908F_2$ gives a check yield of 548,54 kilos, as against the best improved yield of 968.24 kilos per hectare (Table VII, $3908F_2$-II-7). The yield mentioned for the selection in every variety is that which is gotten from the best single test-row.

The results seem to indicate that much can be expected from this method of improvement. However, the average production per plant in every test-row was lower than the yield of the mother plant which produced the test row. For instance, the average yield per plant of such an exceptional test-row as $406F_5$-II-16, Table VII, is 15.28 grams, while the yield of the mother plant, $406F_4$ -I-16, Table VI, is 24.4 grams. This is accounted for by the fact that in every test row there were several low-yielding plants, which bring down the average yield.

The test rows having a large percentage of undesirable plants were eliminated. Only the best-yielding test rows of each variety were saved for future use in the multiplication culture. From these exceptional test rows, several average plants were isolated for the recording of the characteristics. These data are given in Table VIII.

TABLE VIII

Plants	*Height of plant in cm.*	*No. of branches*	*Wt. per plant in gm.*	*No. of pods*	*Yield per plant in gm.*	*Wt. of 100 seeds in gm.*
523 F_5-II-16-a	60	6	149	40	20.2	4.0
523 F_5-II16-b	58	7	105	36	18.4	4.0
523 F_5-II-19-a	48	6	183	41	20.3	3.9
523 F_5-II-19-b	50	7	144	30	18.5	4.1
523 F_5-II-19-e	60	5	180	37	17.8	4.0
523 F_5-II-8-a	56	6	109	40	21.8	4.0
523 F_5-II-8-b	63	7	138	45	25.6	4.0
406 F_5-II-16-a	60	6	90	53	20.1	4.0
406 F_5-II-16-b	48	6	88	59	25.0	3.9
406 F_5-II-13-a	61	6	90	30	20.0	4.0
406 F_5-II-13-b	50	4	83	38	26.8	3.9
406 F_6-II-13-c	65	6	108	46	24.3	3.8
$3908F_2$-II-7-a	96	5	120	51	21.0	4.0
$3908F_2$-II-7-b	85	6	106	30	15.6	4.1
$3908F_2$-II-7-c	84	5	99	46	22.6	4.0
$3908F_2$-II-14-a	70	4	100	53	17.8	4.0
$3908F_2$-II-14-b	66	6	88	49	16.5	3.9
$3908F_2$-II-14-c	50	5	98	33	14.4	4.1

An attempt was made to plant a small portion of the seed obtained from the exceptional row, $406F_5$-II-16, as a third culture, but as this strain is not well adapted to the dry weather conditions prevailing this year from January to March, a poor result was obtained and not recorded. This strain ought to be planted in the same season, next year.

Regarding the other improved strains, $3908F_2$-II-7, and $523F_5$-II-16, no third culture was attempted, because there was not sufficient time left to carry out the experiment.

SUMMARY

1. Of the varieties tested for May and August, only the early-maturing variety 406 produced fair returns of seeds. The other varieties made much herbage at the expense of the pods.

Green manure can best be obtained with this crop during the early part of the rainy season, as in such weather many varieties produce abundant stems and foliage.

3. The climatic conditions that prevailed from August to October greatly influenced the production of seeds and vegetable matter. All varieties gave a good yield then.

4. The latter part of the rainy season or the earlier part of the dry season seemed to be the most suitable time for *mungos*.

5. Only three varieties grew most successfully during the dry season. Of these, two are native and one is foreign. The native varieties are 523 and 4780, and the foreign is 3908, from Java.

6. Of the foreign varieties, 406, 4303, and 4394 are adapted to wet seasons, neither too wet nor too dry being most suitable to the last two varieties. They gave a very poor yield in the dry season.

7. Hard rain and wind hampered pollination and resulting in the failure to produce many pods.

8. Moderate rainfall during the early start of the plant was as beneficial to the growth as was rain just previous to flowering.

9. Manure, when applied as fertilizer, produced good vigorous plants, but did not increase the yield of seed.

10. Ash increased the seed production. It stiffens and hardens the body of the plants.

11. Light soils are most desirable for seed production.

12. It paid to improve varieties 406, 523 and 3908 by selection.

ACKNOWLEDGEMENT

The writer is indebted to Prof. C. F. Baker for his valuable directions and criticisms during the progress of this work.

BIBLIOGRAPHY

1. *Commercial Products of India*, by George Watts.

2. Bulletin 119, United States Department of Agriculture.

3. *Cyclopedia of American Horticulture*, edited by L. H. Bailey.

4. Yearbook of the United States Department of Agriculture, 1908.

5. *Philippine Agriculture*, by E. B. Copeland.

6. *Philippine Agricultural Review*, Vol. IV, No. 8.

7. *Philippine Agricultural Review*, Vol. VIII, No. 2.

8. Bulletin 32, Kansas Experiment Station.

The Relation of Experimental Work to Extension and Demonstration.

By Faustino Q. Otanes

The object of demonstration is to place before the farmer a practical object lesson. It is the application of the findings of science in the Experiment Station. But in order that these findings be worthy of general recommendation they must first be tested under such different conditions as exist in different locations. This is the purpose of extension work.

To recommend to farmers in the Philippines successful and practical experimental results and successful farm operations, as known in temperate countries, or to recommend the result of a successful experiment in Lanao to farmers in Ilocos Norte without first testing it in that locality, is to run the risk of involving the farmers in a game of chance. There is danger in this: if the result is a failure the faith of the farmer in the work and aim of the government is weakened and the improvement of agriculture is retarded.

There are no more potent factors than extension and demonstration to bring before the farmers the results of experimental work that may improve their farm operations. Neither lectures, bulletins, nor periodicals, alone, can accomplish this work. The minds of old farmers are more or less fixed and change in them is slow. This is especially true in the Philippines where farmers attach certain superstitions to their farm operations and where the great mass of farmers are so illiterate that bulletins or periodicals are of little value. Before our farmers will take advantage of experimental results and innovations, they must see with their eyes the practical utility and the benefits that can be obtained from them.

Campus News

Mr. Guy Clinton, instructor in Chemistry, was granted retirement at the end of the past college year, after more than ten years in the Philippine service.

Dr. Manuel Roxas, B.S.A., 1911, M.S., 1913, who has just taken his doctor's degree at the University of Wisconsin, is expected to take the place left vacant by Mr. Clinton, beginning September 4.

Mr. Bienvenido M. Gonzalez, B. Agr., 1913, who took his master's degree at Wisconsin in 1915 and spent the following year in further work there, and in visits to various American agricultural colleges, returned for duty as instructor in Animal Husbandry, June 12.

Mr. Otto Reinking, appointed to the new position of instructor in Plant Pathology, began his work July 5. Mr. Reinking holds bachelor's and master's degrees from the University of Wisconsin, where his training was under the most eminent American teacher of plant pathology, Professor L. R. Jones. Mr. Reinking was at the Colorado Agricultural College last year, and has had some tropical experience in Hawaii.

Nemesio Mendiola, M.S., assistant in Agronomy, has been granted a University fellowship for foreign study, and has gone to Cornell, where his special subject is to be plant breeding.